FUNCTIONAL BIOTYPOLOGY

Second International Symposium on Human Biology

Visegrád 1979

ANTHROPOLOGIAI KÖZLEMÉNYEK

A MAGYAR BIOLÓGIAI TÁRSASÁG
EMBERTANI SZAKOSZTÁLYÁNAK FOLYÓIRATA

Szerkesztő:
EIBEN OTTÓ

24. kötet 1—2. füzet

4.768

AKADÉMIAI KIADÓ, BUDAPEST
1980

The Symposium organized by the Department of Anthropology,
Eötvös Loránd University, Budapest,
was held at Visegrád between 10th and 14th September, 1979.

Anthrop. Közl. *24;* 3—7. 1980.

ON THE FUNCTIONAL BIOTYPOLOGY

Opening lecture

by O. G. EIBEN

(Department of Anthropology, Eötvös Loránd University, Budapest Hungary)

Human biology continues to examine the relationship between structure and function of the human body with unchanged interest even until this day. From the theories of physical typology suggested by genetic determination we have come, namely, to the so-called *functional* typologies in our age. Modern human biology strives for a totality of a certain kind when choosing the somatic and psychologic complex of man for the subject of its examination. In other words, it also recognizes the psychologic constitution besides physique. Physique as somatic/morphological/physical constitution is being examined together with the ethological and ecological aspects in an ever growing number of instances.

Permit me, please, to take a brief retrospective glance. This Symposium offers me the opportunity to mention the Hungarian researchers, too, who made their mark in the fields of functional typology.

To the fundamental ideas of philosophy, like "matter" or "form" I merely refer here (cf. WOLSKY 1942). In the present introduction I would rather concentrate upon the fundamental biological notions of *structure* and *function.* The relationship of these two has held the attention of researchers from the oldest times. It can be considered as a *basic principle of biology*, that each structure becomes suitable for performing a definite function by the very peculiarity of its construction. In the majority of cases it is easy to perceive the connection of structure and function. For example the relationships between the dense vascularity of the parenchymal organs, of the liver, the kidney, the heart and their considerable oxygen demand, and further between the curvatures and the resilience, or flexibility of the spinal column, as well as the spatial arrangement of the elements of bone tissue and mechanical load are conspicuous (KISZELY 1970).

Up until now anthropology examined its subject mostly and preponderantly statically. The greater part of our attainments has been inspired by morphology. However, one must not lose sight of the circumstance that structure and function are sides of the same material system, which possibly should be taken simultaneously into consideration. Yet these two aspects of the phenomenon are manifested not only by their inseparability but by a relative independence of each other as well. A given structure or parts of it may change without any alteration ensuing in the functional characteristic of that structure. Yet it has also been reported that the biological systems of identical structure worked functionally different (KISZELY 1970).

Our future objective should be to search for the functional meaning of the given structures at the time they are recognized. We should try to connect the functions more intensively with the structural characteristics.

Naturally, this is not a new endeavour in biology, yet it becomes increasingly significant today. Relatively soon after the macroscopic analysis of structure and function, came the microscopic examination (cellular and then intercellular analysis). Intercellular structure could be experimentally influenced as early as the 1930s. However, on the intercellular level the way was opened only after a significant advance in genetics. With the development of ultrastructure research, as well as with the biophysical and biochemical methods the relationships between the structural and functional characteristic of the living organisms are being examined nowadays on the level of the protein molecule. The electron microscopic examination of the ultrastructure led to the recognition of new functions.

Another field of research is the examination of the connection between somatic and psychic constitution. HIPPOCRATES described his generally known humoral-pathologic types nearly two and a half thousand years ago. This was one of the earliest typologies.

Its fundamental ideas are still being used. Homo sapiens is just as variable in his psychic characteristics as in his physique. As is usually said, "so many people so many characteristics". Each man is an independent unity, a personality. The features characteristic of personality are — as is known — in interaction with one another, whether they are morphological characteristics or psychic properties. By these are man's interpersonal relations determined. Let us remember two such well-known figures as *Falstaff* or *Cassius*, for example.

All the properties referred to above concentrate round certain characteristics, and also the elements of the examined samples (i.e. the people) concentrate there. With an increase of the distance from these foci, the distribution gets thinner (HALÁSZ—MÁRTON 1978). This is, in fact, the foundation of type forming.

I cannot undertake here, however tempting it is, to offer a complete survey of the wide variety of typologies. Mainly from the second half of the past century these have not only been great in numbers, but also their directions have displayed great variety.

Also BENEKE, a pathological anatomist who worked in Vienna, contributed in a considerable degree to the development of a scientific morphological typology. Of the *first morphological anomaly* described by him, a small heart, narrow vascular system, large lungs, small liver, short small intestine, weak muscles and a slender osseous system are characteristic. In the case of the *second morphological anomaly* he observed the opposite of all of these, i.e. a large heart, wide vascular system (relatively narrow pulmonary artery), small lungs, large liver, long and wide small intestine, well-developed osseous and muscle systems, thick fat pad (BENEKE 1878, 1881, BUDAY 1943).

On these types the Hungarian author Bertalan STILLER gave a most detailed description — also the terms "habitus asthenicus" and "habitus apoplecticus" originate with him (STILLER 1884, 1907, EIBEN 1977).

As shown by the names of these types, it was assumed that for the genesis of certain diseases specific predisposing factors were necessary, and that for these the physique was responsible. At the same time one can clearly perceive here that type is, at any time, an abstraction. The extremes, the rather infrequent "pure types" are in most cases pathological. Let us only consider KRETSCHMER's (1921) constitutional types, maybe best known even to the general public. Or let us consider the patients suffering from Turner's or Down's syndromes. Not only their physique and somatotype, even their karyotype and behaviour are characteristic. Here the defective structure has a certain hypofunction as a result (EIBEN et al. 1974; BŐSZE et al. 1980).

Function thus depends on structure and within this on the proportions of the component parts of that structure. EMPEDOCLES (5th cent. B.C.) revived much earlier doctrines of the primitive materialism of the ancient eastern cultures. According to him just as everything else in the world, the human body itself is a mixture of four fundamental elements: fire, water, air and earth. Healthy man is characterized by a proportional distribution of the four elements (HALÁSZ—MÁRTON 1978). In recent times THOMAS was first to use the state of development, the relative preponderance of the single organ systems as a type-forming element in his typology (cf. abdominal type, thoracic type, cephalic type; THOMAS). This line of research reached completion in SHELDON's (1940) works.

SHELDON's somatotyping method examined the various organ systems one after the other (as well as their predominance).

With regard to the subject of the present Symposium, all tissues, organs or organ systems of mesodermal origin are worthy of special attention. Mesenchyme is a sort of tissue of primaeval origin: phylo- and ontogenetically it is the oldest kind of supporting (connective) tissue. It is the fundamental tissue from which all other supportive tissues take their origin. Moreover, even the blood-vessel, the blood, the medulla and the muscle tissue developed from it. Its cells continue to exist scattered in the adult organism and enable regeneration, as well as further development in various directions (TÖRŐ 1952). The mesenchyme can be influenced in extrauterine life. Regarding the bone, I refer to the outstanding work of the Hungarian experimental morphologist KROMPECHER (1956). In the case of the muscle, the changes brought about by physical work and sporting, as well as by disease and continuing inactivity are obvious.

If we still ascribe significance to mesenchymosis (an anomaly of the osseous- and articular systems) today, then it is of interest that the mesenchyme may (also) be formed intercellularly; consequently it can be grown — at least in vitro — in the extrauterine life. May I remark here that research on connective tissue has been rather intensive in Hungary from the 1930s on, as it appears from HUZELLA's (1943) work.

Consequently, somatic variation can be expanded by cytological and histological aspects.

Abandoning the somatological types, PAVLOV elaborated a neurophysiological typology, primarily on his experimental animals. The exact neurophysiological reaction types of these dogs could be surprisingly identified HIPPOCRATES's impressive empirical types which had, however, no scientific foundation in today's sense (PAVLOV 1956).

PAVLOV deserves credit for making a further step towards the human peculiarities. He recognized that the four neurophysiological types of physique were not primarily characteristic of man, but that the characteristics of the human neoformations of the cerebral cortex were more important. In the overwhelming majority of people the sensorial i.e. picture-like and the conceptual i.e. verbal perception and reflection of reality are roughly balanced. There are, however, two characteristic extremes: in one of these the sensory or (in PAVLOV's words) first signalizing system is dominant, while in the other the verbalizing, i.e. second signalizing system prevails. We meet here a neurofunctional classification, which thus differentiates, and is, therefore, more than the cerebral or ectomorphic types of primarily morphological character.

It is another matter that the rather complex system of problems of functional biotypology can hardly be comprehended by single branches of science. Biophysicists, biochemists, cytologists and histologists, morphologists, physiologists, psychologists, sports researchers and numerous others together with physical anthropologists/human biologists may attempt multidisciplinary cooperation for the well-grounded expectation of success.

*

I open our Symposium with a brief look at all these problems. I am reminded of our first meeting arranged at Balatonfüred in September 1976. In that "Balaton Symposium" we chose *Growth and Development; Physique*, for our subject. On the present occasion, here at Visegrád, in this "Danube Symposium", the subject is *Functional Biotypology*. On the evidence of the list of participants and in the knowledge of the presentations included in the programme I can say that the multidisciplinary character of our Symposium is ensured. I sincerely hope that the papers and the debates following them will bring notable results to our subject.

At the same time, I should like to mention that our subject touches upon the biology of children in quite a number of respects. Accordingly, we intend also to contribute to the success of the *International Children's Year* through our Symposium.

I feel sure that the present meeting — just as also the Balaton Symposium three years ago — will include numerous new instances of cooperation, the establishment of further professional and friendly relations. And if, as a result of all these, international human biological research continues to grow and expand and provides further fine results, the organizer of this Danube Symposium will be amply rewarded.

I wish you all the very best for a successful Symposium!

REFERENCES

BENEKE, F. (1878): *Anatomische Grundlagen der Constitutionsanomalien des Menschen.* — Marburg.

— (1881): *Constitution und constitutionelles Kranksein des Menschen.* — Marburg.

BŐSZE, P.—EIBEN, O. G.—GAÁL, M.—LÁSZLÓ, J. (1980): Body measurements of patients with streak gonads and their bearing upon the karyotype. — Hum. Genet. *54;* 355—360.

BUDAY, L. (1943): *Orvosi alkattan* (Medical textbook on physique. — In Hungarian). — Budapest.

EIBEN, O. G. (1977): Hungarian investigations concerning growth and development and the variation of physique (Opening lecture). — *in* EIBEN, O. G. (Ed.): *Growth and Development Physique* — Symp. Biol. Hung. *20;* 11—15.

EIBEN, O. G.—SÁNDOR, G.—LÁSZLÓ, J. (1974): Turner-syndromások testalkata (The physique of patients suffering from Turner's syndrome). — Anthrop. Közl. *18;* 41—48.

HALÁSZ, L.—MÁRTON, L. M. (1978): Foreword. — *in* HALÁSZ, L.—MÁRTON, L. M. (Eds): *Típustanok és személyiségvonások.* 5—38. — Gondolat, Budapest.
HUZELLA, T. (1943): *Die zwischenzellige Organisation auf der Grundlage der Interzellulartheorie und der Interzellularpathologie.* — G. Fischer Verlag, Jena.
KISZELY, G. (Ed.) (1970): *Biológia.* — Medicina, Budapest.
KRETSCHMER, E. (1921): *Körperbau und Charakter* (26th ed. 1977). — Springer-Verlag, Berlin—Heidelberg—New York.
KROMPECHER, I. (1956): Kvantitatív és kvalitatív funkcionális adaptáció. — Az I. Biológiai Vándorgyűlés Előadásainak Ismertetése. 16—17. — Magyar Biológiai Társaság, Budapest.
PAVLOV, I. P. (1956): *Összes művei,* Vol. III. *2;* 216. — Akadémiai Kiadó, Budapest.
SHELDON, W. H.—STEVENS, S. S.—TUCKER, W. B. (1940): *The Varieties of Human Physique.* — Harper and Brothers Publ. New York and London.
STILLER, B. (1884): Nervous stomach ailments (In Hungarian). — cit. BUDAY 1943.
— (1907): *Az asthenias alkati betegség — Asthenia universalis congenita.* — Budapest.
THOMAS *cit* HALÁSZ—MÁRTON, 1978.
TÖRŐ, I. (1952): *Szövettan* (Textbook of Histology). — Budapest.
WOLSKY, S. (1941): „Matéria" és „Forma" a kísérleti alaktanban ("Matter" and "Form" in experimental morphology). — Szt. István Akadémia Értesítője, *26;* 1—15.

Author's address: Dr. EIBEN OTTÓ
Dept. Anthropology, Eötvös Loránd University
H-1088 Budapest, Puskin u. 3.
Hungary

Anthrop. Közl. *24;* 9—14. 1980.

A MULTIVARIATE APPROACH TO THE MORPHOLOGY OF A POPULATION OF CHILDREN IN GENEVA AGED FROM 4 TO 19½ YEARS

by M. Bakonyi and P. Moeschler

(Department of Anthropology, University of Geneva, Geneva, Switzerland)

Abstract. A factor analysis by principal components was conducted on anthropometric variables from a sample of 5578 children and adolescents aged 4 to 19.5 years, living in Geneva, Switzerland. The variables used in this analysis are biacromial diameter, sitting height, weight, upper arm length, total arm length, arm cirumference, bicristal diameter, bizygomatic breadth, leg length, face height, antero-posterior diameter, transverse diameter, subscapular skinfold, triceps skinfold. Mean values by sex were calculated at half-year intervals. The main results obtained are as follows.

The first factor is a general growth factor, the second and third factors account for the evolution of morphology through time. This is particularly clear when these latter two factors are related to the first. The second factor is bipolar, opposing weight and breadth measurements to head and length measurements. The skinfolds play an important role in this factor, particularly the triceps skinfold. The third factor is more complex and can be characterized by the importance of the weighting attributed to the subscapular skinfold.

Briefly, a principal components analysis reveals the part played by skinfolds during growth and brings out the evolution of the morphological type. A discussion of this last point is developed in this paper.

Key words: growth and development, Geneva children, factor analysis by principal components.

Introduction

Certain methods frequently used in multivariate analysis have the advantage that they give an idea of the possible structures of a set of data in the absence of any hypothesis. This is what incited us to use the analysis by principal components for the study of growth of the children of Geneva. Even though the very nature of our data leads to an analysis of a particular correlation matrix (the coefficients all have very high values) with the consequence that the first factor in itself explains 88% of total variance, it seemed interesting to present here what the results of our calculations could suggest.

Material and Methods

This study concerns a sample, representative of the Swiss population of Geneva, constituted of 5578 children and adolescents (2860 boys and 2710 girls) aged from 4 to 19½ years, measured in 1972 and divided into six month's age-groups. For each of the 62 age groups thus obtained we have calculated the mean values of the 14 measurements appearing in Table 1. These sixty-two groups each characterized by 14 mean values, constitute the total data (sexes and age-groups combined) on which a factor analysis by principal components has been carried out. The results of this analysis are examined here factor by factor.

Results

Factor one (Table 1)

The first factor is a general growth factor which gives the age groups according to the ascending order of their mean values.

Table 1—Factor 1

Biacromial	0.2831
Sitting height	0.2831
Weight	0.2823
Upper arm length	0.2823
Total arm length	0.2817
Arm circumference	0.2806
Bi-iliocristal	0.2803
Bizygomatic	0.2797
Leg length	0.2795
Face height	0.2770
Antero-posterior diameter of the head	0.2580
Transverse diameter of the head	0.2548
Scapular fold	0.2284
Triceps fold	0.1643

Therefore it is not surprising at all that these mean values appear along the axis on which they figure (Figure 1) in the ascending order of the subject's average age-groups, taking into account sexual variation.

Factor two (Table 2)

The second factor is bipolar, opposing skinfolds to the head measurements. This allows us to separate the sexes in an almost perfect manner (with one exception: boys of 4 to 4½), the value of the function is at all tissues, lower for the boys than for the girls, and this no matter what age group is compared (Fig. 1).

Table 2—Factor 2

Triceps fold	0.6911
Scapular fold	0.4698
Bi-iliocristal	0.1123
Arm circumference	0.0795
Weight	0.0223
Sitting height	0.0208
Upper arm length	0.0098
Leg length	−0.0189
Biacromial	−0.0331
Total Arm Length	−0.0523
Bizygomatic	−0.1190
Face height	−0.1629
Antero-posterior diameter of the head	−0.3321
Transverse diameter of the head	−0.3557

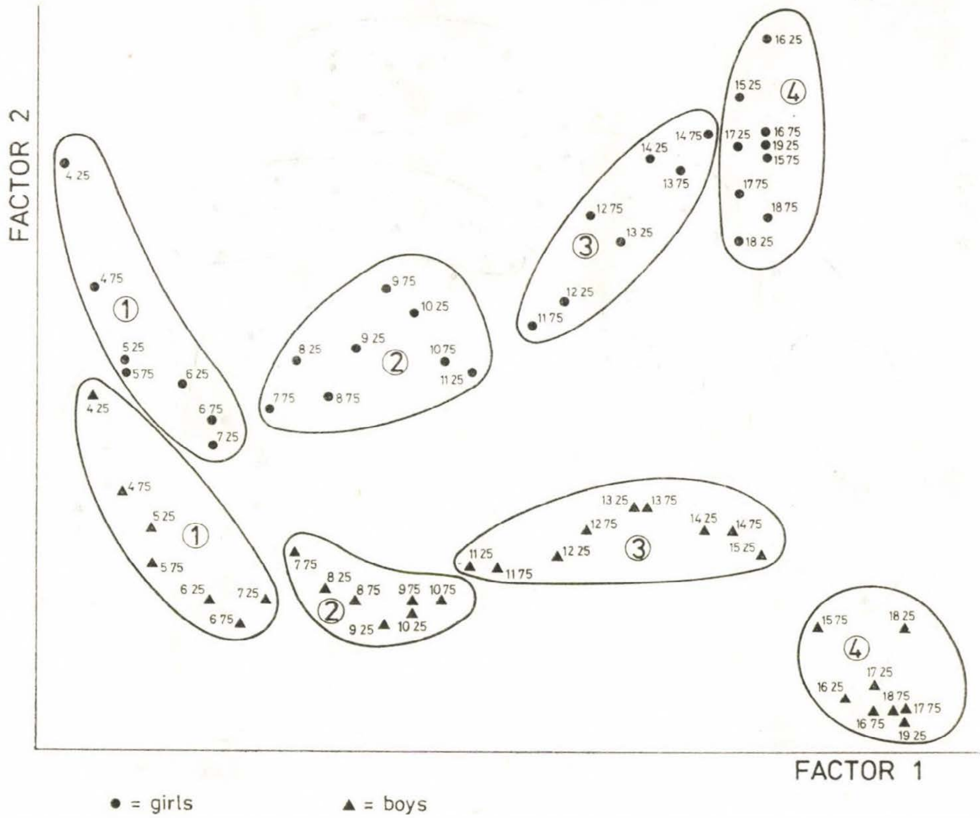


Fig. 1: Factor 1 and factor 2. Age-group distribution (see text). ● = girls, △ = boys

Factor three (Table 3)

Table 3—Factor 3

Leg length	0.4495
Total arm length	0.2744
Upper arm length	0.2582
Triceps fold	0.2185
Face height	0.1051
Sitting height	0.0694
Biacromial	0.0561
Bi-iliocristal	−0.0121
Bizygomatic	−0.0853
Arm circumference	−0.1007
Weight	−0.1167
Transverse diameter of the head	−0.2675
Antero-posterior diameter of the head	−0.2904
Scapular fold	−0.6341

The third factor differentiates the length measurements and the triceps fold from the scapular fold, head measurements and, in a more general manner, from the volume indicators (weight, perimeters and transverse diameters).

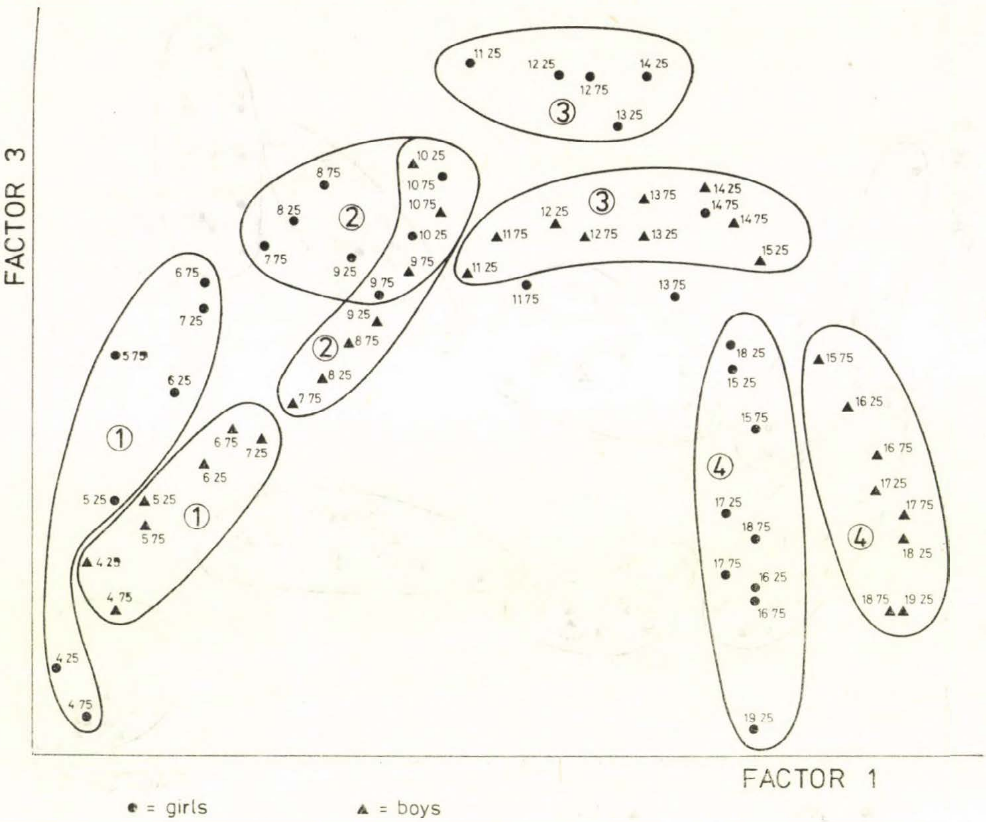


Fig. 2: **Factor 1 and factor 3. Age-group distribution (see text). ● = girls, △ = boys**

The values of the function are approximately the same for the oldest and the youngest boys and girls (Fig. 2). These values are at all tissues higher for the boys, as they are for the girls at or around the age of puberty.

Typological analysis

The global comprehension of the combination two by two of the factors 1, 2 and 3 (Figures 1, 2 and 3) suggests for each sex the existence of four different morphological types relative to the 14 variable involved. They are in Figure 3. The first regroups the age groups comprised between 4 to 7½ years, the second those between 7½ to 11 years, the third those between 11 to 15½ years for the boys and 11 to 15 years for the girls. Lastly, a forth group includes for both sexes the oldest individuals. We want to point out that age limits between groups are almost the same for both sexes.

The same analysis by principal components carried out for each sex separately permits us to verify the existence of the four mentioned groups.

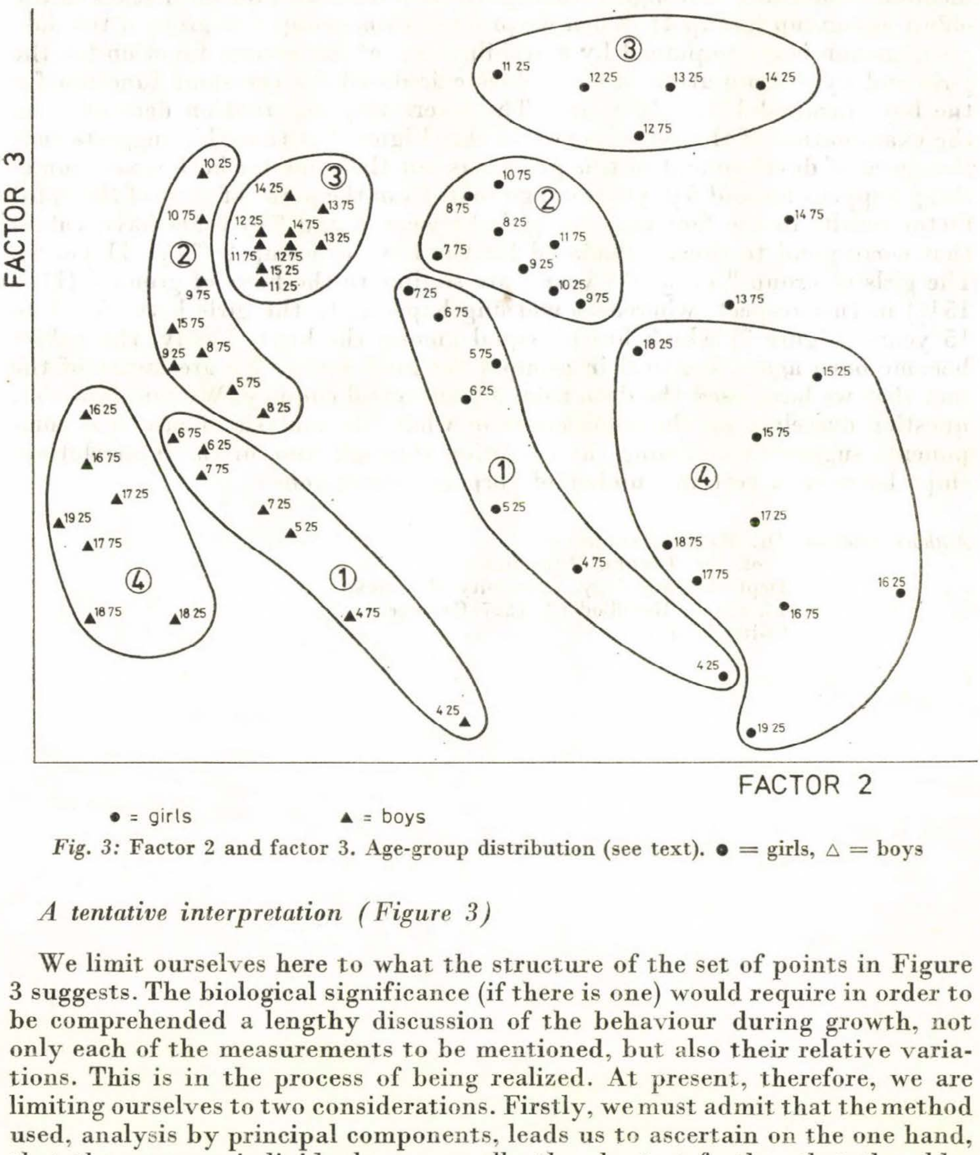


Fig. 3: **Factor 2 and factor 3. Age-group distribution (see text). ● = girls, △ = boys**

A tentative interpretation (Figure 3)

We limit ourselves here to what the structure of the set of points in Figure 3 suggests. The biological significance (if there is one) would require in order to be comprehended a lengthy discussion of the behaviour during growth, not only each of the measurements to be mentioned, but also their relative variations. This is in the process of being realized. At present, therefore, we are limiting ourselves to two considerations. Firstly, we must admit that the method used, analysis by principal components, leads us to ascertain on the one hand, that the younger individuals are equally the shortest further that the older individuals are the tallest (factor 1), and on the other hand that, independently of age, the boys are always different from the girls and that these differences are greater between the older individuals (factor 2). This confirms that the method used can lead to certain evident results which are not even questionable. Therefore, it is worthwhile to examine closely, in Figure 3, the evolution through time of factor 3. First of all, we remark that the age-groups as defined above behave in this respect in an identical manner for both sexes: the mean value of the function regularly increases up to 15 years of age (low values in 1, medium values in 2 and high values in 3), then decreases for both sexes in the oldest age-group (group 4). When we proceed from group 3 to group 4 this last phenomenon is accompanied by a stabilization of the second function for the girls and by a diminution of the values calculated for the same function for the boys (around 15½—16 years). The interesting observation derived from the examination of the set of points in this Figure 3 is that this suggests that the speed of development of this process is not the same for both sexes: something happens around 5½ years of age that, from the point of view of the third factor results in the fact that the girls between 6 and 7½ years have values that correspond to those calculated for the boys of group 2 (7½—11 years). The girls of group 2 (7½—11 years) are similar to the boys of group 3 (11—15½) in this respect, whereas something happens to the girls between 11 to 15 years (Figure 3) which has no equal among the boys. Lastly, the values become once again identical in group 4 for both sexes. We are aware of the fact that we have used the data from a transversal enquiry. We can, however, question ourselves on the significance of what the analysis of principal components suggests concerning the evolution through time of the interrelationships between a certain number of corporal dimensions.

Authors' address: Dr. Maria Bakonyi
Prof. Dr. Pierre Moeschler
Dept. Anthropology, University of Geneva
12, rue G. Revilliod CH-1227 Carouge
Switzerland

Anthrop. Közl. 24; 15–21. 1980.

BODY STRUCTURE AND SOMATOTYPE IN PHYSICAL EDUCATION STUDENTS

by G. BEUNEN and A. VAN HELLEMONT

(Institute of Physical Education, Catholic University Leuven, Heverlee, Belgium)

Abstract. From several studies it appeared that the predictive value of body measurements is fairly low for the mesomorphy component. In the present study on 51 physical education students we predicted the somatotype components from 25 body measurements and 9 tissue measurements taken on radiographs of the upper arm, thigh and calf. The somatotype was determined according to a modified anthroposcopic Sheldon technique.

The interrelationships between the somatotype components, body and tissue measurements were analysed by means of factor analysis (maximum likelihood, varimax, oblimin); stepwise multiple regression analysis was used to determine the predictive value of the body and tissue measurements. After oblique rotation four significant factors were extracted: *a general size factor*, a factor of *muscle development-mesomorphy*, a factor of *fat-endomorphy* and a fourth factor which we tentatively call *limb development*. The predictive value of a combination of body and tissue measurements amounted to R = .89 for endomorphy, R = .86 for mesomorphy and R = .90 for ectomorphy.

The inclusion of tissue measurements in the regression analysis seems to increase significantly the prediction of mesomorphy ratings.

Key words: physique, body measurements, tissue measurements on radiographs, somatotype, physical education students.

Introduction

Since SHELDON in 1940 proposed his method on somatotyping (SHELDON, STEVENS and TUCKER 1940) several modifications of his original work have been put forward (see e.g. CARTER and HEATH 1971). Most of these modifications concern the extension of the 7-point scale and the objectifications concerning the extension of the 7-point scale and the objectivity in somatotyping. To obtain a more objective system several authors attempted to predict the three components from body measurements by multiple regression techniques (DAMON et al. 1962, MUNROE, CLARKE and HEATH 1969, WILMORE 1970), while PARNELL (1954, 1958) and HEATH and CARTER (1967) proposed new methods based on anthropometry.

During the same period several authors have identified the structure of physique by means of factor analyses of body measurements. In a survey of these studies SIMONS and VAN GERVEN (1970–1971) concluded that most probably the structure of the head, hand and foot is independent of the structure of trunk and limbs and that in the trunk and limbs the following structure could be identified:

— size factor,
— limb-bone length,
— limb-bone width,
— fat thickness,
— muscle width.

These conclusions are in close agreement with the findings of TANNER who analysed the structure of physique by means of tissue measurements on radiographs (TANNER 1964).

In this study we analyse the factor structure of physique described by body measurements, tissue measurements on radiographs and somatotype components; furthermore, the predictive value of body and tissue measurements in identifying somatotype components was examined.

Material and Methods

Subject

The sample consisted of 40 male students who started Physical Education studies at the K.U. Leuven in 1973. Their chronological age varied between 18.1 and 25.7 years with a mean of 19.4 years.

Variables

The body measurements were taken by experienced anthropometrists. A description of the measurement techniques is given by SIMONS et al. (1978).

The soft tissue X-rays were taken in a standard position from the upper-arm, thigh and calf.

For the positioning of the subject the instructions given by TANNER (1962) were carefully followed. The measurements of the tissue components were taken in the middle between olecranon and acromion for the upper arm, half-way between the spina iliaca anterior superior and the upper border of the patella for the thigh; for the calf 1|3rd of the distance between the external epicondyle of the femur and the external malleolus below the external epicondyle. These points were marked with a lead marker and the limb was positioned so that the middle of the roentgen unit, the lead mark on the skin and the middle of the cassette which was also marked with a thin steel wire, were in the same horizontal plane.

The measurements on the X-rays were taken at the marked levels described above, with a sliding caliper for measurements on photographs with an accuracy of 1/10th of a millimetre (John Bull, British Indicators Ltd, St. Albans). The intraobserver reliability of the tissue measurements made on the same X-rays ranged from $r_{tt} = .90$ for the fat tissue to $r_{tt} = .999$ for the muscle tissue. These were no statistically significant systematic differences between the first and second measurements.

The somatotype ratings were carried out by the same observer (G.B.) according to a modified Sheldon technique developed for use in the Leuven Boys Growth Study (SIMONS et al. 1978) and described in detail by CLAESSENS et al. (1979). This method is essentially an anthropometric-anthroposcopic somatotype method based on the Atlas-technique of SHELDON (SHELDON, DUPERTUIS and MCDERMOTT 1954) whereby first estimates of endomorphy and ectomorphy are made using the tables developed by PARNELL (1958) and HEATH—CARTER (1967).

In Table 1 a list of the measurements is given.

Table 1

List of measurements taken on male physical education students

Anthropometry	*Tissue measurements*
— Height	— Fat width:
— Weight	. Arm
— Biacromial diameter	. Thigh
— Bi-iliac diameter	. Calf
— Transverse chest	— Muscle width:
— Chest depth expir.	. Arm
— Bicondylar femur	. Thigh
— Bicondylar humerus	. Calf
— Chest circumf. difference	— Bone width:
— Chest circumf. expir.	. Arm
— Abdominal circumf.	. Thigh
— Hip circumf.	. Calf
— Thigh circumf.	
— Calf circumf.	
— Upper arm circumf. flexed	*Somatotype components*
— Supra-iliac skinfold	
— Triceps skinfold	Endomorphy
— Sub-scapular skinfold	Mesomorphy
— Calf skinfold	Ectomorphy

Statistical procedures

The factor analysis was carried out according to the maximum likelihood principle using a computer program described by PEETERS (s. d.). The initial communalities are estimated by means of the squared multiple correlations. After the factors have been extracted, these are rotated to an orthogonal simple structure according to the Varimax method after which an oblique rotation into a simple oblique structure is carried out (Oblimin method).

The multiple correlations between the somatotype components and the anthropometric and tissue measurements were calculated by means of a step-wise multiple regression computer program described by BOECKX (1973). The partial variance of the dependent variable that could be explained by each independent variable to be entered in the equation, was tested by means of an F-test (significance level set at $\alpha = .05$).

Results

The factor analyses revealed that four significant factors could be extracted. The first factor could be identified as a *size factor*. Height, weight, and circumferences of the chest, abdomen and hip load high on this factor (see Table 2). On the second factor, which we call a *muscularity—mesomorphy factor*, a high loading is found for mesomorphy, the muscle tissue measurements taken at

the upper arm, thigh and calf, the circumferences of the limbs and ectomorphy. The third factor is called *adiposity—endomorphy*. Endomorphy loads highest on this factor, followed by the skinfold measurements, the fat tissue measurements and the circumferences. The fourth factor is not so clearly defined. We tentatively call this factor a *limb development factor* since the highest loadings are found for ankle breadth, bone tissue measurements, calf circumference and height and weight.

Table 2

Factor structure (maximum likelihood, varimax, oblimin) after oblique rotation of anthropometric measurements, tissue measurements and somatotype components on 40 male physical education students (only the highest factor loadings above .45 are reported)

Factor I size		Factor II muscularity — mesomorphy		Factor III adiposity — endomorphy		Factor IV limb development	
Weight	.871	Ecto	−.871	Endo	.941	Ankle breadth	.705
Abdom. circ.	.859	Meso	.779	Subscap. sk.	.820	Calf. circ.	.594
Hip circ.	.844	Up. arm circ.	.648	Suprail. sk.	.802	Weight	.540
Height	.841	Up. arm muscle	.641	Tric. sk.	.797	Height	.492
Chest circ.	.820	Calf muscle	.635	Thigh fat	.722	Up. arm bone	.483
Biacr. diam.	.751	Calf circ.	.594	Calf fat	.687	Calf bone	.456
Bic. fem.	.700	Thigh circ.	.547	Weight	.685	(Up. arm bone	.330)
Thigh circ.	.687	Thigh muscle	.422)	Chest circ.	.669		
Transv. chest	.637			Up. arm. fat	.666		
Bic. hum.	.620			Abd. circ.	.659		
Calf circ.	.573			Calf circ.	.543		
Up. arm circ.	.559			Thigh circ.	.542		
Sub. scap. sk.	.546			Hip circ.	.538		
Chest depth	.535			Calf sk.	.487		
Bi-il. diam.	.527			Up. arm circ.	.478		
Supra-il. sk.	.483			Biacr. diam.	.484		
Up. arm bone	.481			Chest depth	.467		
Ankle breadth.	478						
Endo	.455						
Thigh muscle	.454						

The intercorrelations between the four extracted oblique factors were very low, ranging from .431 between the size and adiposity–endomorphy factor to .110 betwen the adiposity—endomorphy and limb development factor.

In order to evaluate the predictive value of the anthropometric and the tissue measurements in predicting somatotype components a stepwise multiple regression analysis was carried out.

In Table 3 the coefficient of determination after each step of the stepwise regression analysis is reported for the three dependent variables. Only the variables that are added to those already present in the regression equation are mentioned together with the coefficient of determination for all variables in the regression equation.

It can be clearly seen that besides fat and skinfold measurements, bone breadth and length diameters enter the regression equation for the prediction of endomorphy. Five measurements account for 79% of the total variance in endomorphy. For mesomorphy the total variance explained, amounts to 74%. The tissue measurement of the upper arm is the most important predictor and here two measurements of skinfolds and of skeletal framework (transverse chest and bi-iliac diameter) enter the equation. Only three variables: height, weight and calf skinfold explain 82% of the total variance in ectomorphy.

Table 3

Multiple correlations (only coefficients of determination are reported) between somatotype components and anthropometric and tissue measurements on 40 male physical education students (for each dependent variable the independent variables entered the regression equation in each step are mentioned)

Dependent variables					
Endomorphy		Mesomorphy		Ectomorphy	
Subscapular skinfold	.61	Up. arm muscle	.27		
Calf fat	.66	Height	.41	Height	.56
Bi-iliac diam.	.72	Transv. chest	.50	Weight	.79
Supra-iliac skinfold	.76	Up. arm circ.	.58	Calf skinfold	.82
Thigh bone	.79	Supra-iliac skinf.	.70		
		Bi-iliac diam.	.74		

Discussion and Conclusions

The somatotype distribution of the physical education students examined in this study was very similar to the distributions reported earlier by CARTER (1964) and SWALUS (1967—1968).

These distributions show striking similarities with the distributions of outstanding male athletes.

The factor structure found herein is in general in agreement with the structure found in similar studies. TANNER (1964) using a maximum likelihood method extracted five significant factors. Three of them are of the same nature as the ones we found. He could, however, differentiate between a limb-bone length and a limb bone breadth factor.

In a study on 336 pre-adolescent and 318 adolescent boys VAN GERVEN (1976) identified three maximum likelihood factors, namely a *length–muscle–width* factor, a *fat* factor and a *mesomorphy–muscle* factor.

SKIBINSKA (1977) too, reported nearly the same three factors. From her studies she concluded that irrespective of sex, number of measurements and population under investigation the three following factors are found:

— a size factor,
— a mesomorphy–muscularity factor,
— an endomorphy–adiposity factor.

Our findings seem to confirm this conclusion. That it was not possible to differentiate in this study between a limb-bone length and limb-bone breadth factor is most probably due to the lack of length measurements of different parts of the body. However, in a separate analysis of the 12 tissue measurements it could be demonstrated that the three tissue components loaded highly on their respective tissue factors, namely a *fat*, a *muscle* and a *bone* factor.

From the factor analysis on all measurements it is also clear that endomorphy and mesomorphy load on a separate factor while ectomorphy loads negatively on the muscularity–mesomorphy factor. Although it is convenient to think of the three somatotype components as three independent or orthogonal components this need not to be true. Probably the interdependency of the components can be explained by some physiological or genetical factors.

From the analysis also appears that muscle and bone width are independent. Mesomorphy is related to muscle width development but not to limb-bone breadth. This confirms the findings of WILMORE (1970) and SLAUGHTER and LOHMAN (1977).

In comparison with the findings of other authors a fairly high percentage of the variance in mesomorphy could be explained using tissue measurements and anthropometric measurement (see Table 4).

Table 4

Coefficients of determination among anthropometric measurements, body composition, tissue components and somatotype components as reported by several authors (males)

Author	Sample measurements	Dependent variables			
		Method	Endo	Meso	Ecto
DAMON et al. (1962)	225 soldiers (anthropometry)	Sheldon, atlas	.61	.44	.81
MUNROE et al. (1969)	207 boys 12Y. (anthropometry)	Heath	.82	.60	.95
SLAUGHTER and LOHMAN (1977)	45 boys 7–12Y. (anthropometry and body composition)	Sheldon trunk index	.78	.21	.74
		Heath–Carter	.83	.74	.81
BEUNEN and VAN HELLEMONT	40 phys. ed. students (anthropometry and tissue measurements)	Modified Sheldon atlas	.79	.74	.82

This leads to the conclusion that the inclusion of tissue measurements in the regression equation adds significantly to the predictive value. Although we would not recommend taking X-rays for somatotyping, it reveals that mesomorphy as defined by the modified Sheldon-technique (CLAESSENS et al. 1979) is closely related to muscle development. As already established, endomorphy can be fairly accurately predicted from skinfold measurements while ectomorphy is closely related to the ponderal index (a correlation coefficient of .90 was found in this study).

Considering the sample involved which shows a specific somatotype distribution, as mentioned above, it could probably be expected that higher predictive values will be found in a normal healthy population of the same age and sex. Since, in the present sample, the variance in each of the somatotype components is reduced in comparison with a representative sample of a total population of the same age and sex.

It should also be noted that in the regression equation for predicting mesomorphy measurements taken at the limbs (upper arm muscle, upper arm circumference) as well as measurements taken at the trunk (transverse chest, suprailiac skinfold and bi-iliac diameter) contribute significantly.

Nevertheleless, neither PARNELL (1954, 1958) nor HEATH—CARTER (1967) include trunk dimensions in the estimation of mesomorphy whereas the discrimination between endomorphy and mesomorphy in Sheldon's trunk index method (1968) is solely based on trunk measurements.

This analysis suggests that in estimating mesomorphy one should take into account the dimensions of the trunk and the limbs as well.

Moreover, as stated at the beginning of this paper, the structure of head, hand and foot is most probably fairly independent of the structure of trunk and limbs. Therefore, we conclude that the separation into different body regions, as proposed by SHELDON et al. (1940) seems to have a statistical meaning. This does not imply that one has to estimate the somatotype for each body region separately but it suggests that, in estimating the somatotype components, one has to take into account the different aspects of the different body regions.

REFERENCES

BOECKX, W. (1973): *Programma stepwise een programma voor stapsgewijze meervoudige lineaire regressie.* — Rapport 17 Rekencentrum, K. U. Leuven, Leuven.

CARTER, J. E. L. (1964): Somatotype methodology and kinesiology research. — Kinesiology Review, 10—19.

CARTER, J. E. L.—HEATH, B. H. (1971): Somatotype methodology and kinesiology research. — Kinesiology Review.; Am. Assn. Health, Phys. Ed. and Recreation, Washington. 10—19.

CLAESSENS, A.—BEUNEN, G.—SIMONS, J.—SWALUS, P.—OSTYN, M.—RENSON, R.—VAN GERVEN, D. (1979): *A modification of Sheldon's anthroposcopic somatotype technique* (in this volume).

DAMON, A.—BLEIBTREU, H. K.—ELLIOT, O.—GILES, E. (1962): Predicting somatotype from body measurements. — Am. Phys. Anthr., *20;* 461—473.

HEATH, B. H.—CARTER, J. E. L. (1967): A modified somatotype method. — Am. J. Phys. Anthr., *27;* 57—74.

MUNROE, R. A.—CLARKE, H. H.—HEATH, B. H. (1969): A somatotype method for young boys. — Am. J. Phys. Anthr., *30;* 195—202.

PARNELL, R. W. (1954): Somatotyping by physical anthropometry. — Am. J. Phys. Anthr., *12;* 209—239.

— (1958): *Behaviour and Physique.* — Eduard Arnold, London.

PEETERS, G. (s. d.): *Factor analysis. A computer program.* — Rekencentrum, K. U. Leuven, Leuven.

SHELDON, W. H.—DUPERTUIS, W. H.—MCDERMOTT, E. (1954): *Atlas of Men.* Harper, New York.

SHELDON, W. H.—LEWIS, P. C.—TENNEY, A. M. (1968): Psychiatric patterns and physical constitution. — *In:* SANKAR, D. U. S. (Ed.): *Schizophrenia: Current Concepts and Research.* 838—912. PJD Publications, Hicksville, New York.

SHELDON, W. H.—STEVENS, S. S.—TUCKER, W. B. (1940): *The Varieties of Human Physique.* — Harper, New York.

SIMONS, J.—BEUNEN, G.—RENSON, R.—VAN GERVEN, D. (1978): *The Leuven Boys Growth Study. — Profile Charts and Growth Curves.* — Instituut Lichamelijke Opleiding. K. U. Leuven, Leuven (internal report).

SIMONS, J.—VAN GERVEN, D. (1970—1971): De dimensies van de lichaamsstrukturu volgens de faktor-analyse methode. *Werken van de Belgische Geneeskundige Vereniging voor Lichamelijke Opvoeding en Sport,* 22B, 45—52.

SKIBINSKA, A. (1977): Factors of body build. — *In:* EIBEN, O. G. (Ed.): *Growth and Development; Physique.* 431—438. Akadémiai Kiadó, Budapest.

SLAUGHTER, M. H.—LOHMAN, T. G. (1977): Relationship of body composition to somatotype in boys aged 7 to 12 years. — The Research Quarterly A.A.H.P.E.R. *48;* 750—758.

SWALUS, P. (1967—1968): Le somatype des étudiants de l'Institut d'Education Physique. — Hermes, Revue Institut d'Education Physique, *2;* 56—68.

TANNER, J. M. (1962): *Growth at Adolescence.* Blackwell, Oxford—Edinburgh.

— (1964): Analysis and classification of physique. — *In:* G. A. HARRISON—WEINER, J. S.—TANNER, J. M.—BARNICOT, N. A. (Eds): *Human Biology* 367—386. Clarendon, Oxford.

Van Gerven, D. (1976): De dimensies van de lichaamsstruktuur volgens de faktor-analyse methode bij een groep pre-adolescenten en adolescenten. — Hermes, Tijdschrift Instituut Lichamelijke Opleiding, *10;* 83—95.
Wilmore, J. H. (1970): Validation of the first and second components of the Heath-Carter modified somatotype method. — Am. J. Phys. Anthr., *32;* 369—372.

Authors' address: Dr. Gaston Beunen
Ann van Hellemont
Instituut Lichamelijke Opleiding Katholieke Universiteit Leuven
Tervuursevest 101.
B 3030 Heverlee
Belgium

Anthrop. Közl. *24;* 23—30. 1980.

PHYSIQUE AND SEXUAL MATURATION

by É. B. BODZSÁR

(Department of Anthropology, Eötvös Loránd University, Budapest, Hungary)

Abstract. The author examined the connection between sexual maturation and physique on the strength of the age at menarche and the anthropometric data of 1118 10—14 year old girls.

She found that the relationship between the time of the onset of menarche and the somatotype (HEATH—CARTER) was significant ($\chi^2 = 70.407$, $p < 0.001$). The somatotype and physique, respectively, of the girls reaching maturity sooner are predominantly endomorphic, and those of the ones maturing later are predominantly ectomorphic. She also examined the relationship between the three components of the somatotype as indicators of the physique on the one hand and age at menarche, on the other. The value of the correlation coefficient between components I and II, respectively, and age at menarche: $r = -0.30$ ($p < 0.01$), that of the one between component III and age at menarche: $r = +0.20$ ($p < 0.05$).

Key words: physique, maturation, Bakony girls.

Introduction

The unity of structure and function is excellently reflected by the differences concomitant with sex appearing in the physique. These differences develop at the time of puberty and, as it is well-known, the puberty of boys takes place about two years later than that of the girls. At the same time, the examinations carried out so far have also demonstrated that there is a relationship between the rate of maturation and physique. KRALJ-ČERČEK (1956) found that among the girls the "baroque type" representing a more feminine form was maturing earlier than the "gothic type" of a more boyish form. According to TANNER's (1962) examinations, the age at menarche of the girls of endomorphic physique is lower than that of the ones of ectomorphic physique.

It can be found on these examination results that the sooner earlier sexual maturation takes place the more suitable the physique is for performing the sexual function.

By the examinations the author wishes to supply with further data for revealing the relationship between maturation and physique.

Material and Methods

In 1977—78 the author conducted a detailed anthropological survey of the growth and physical development of 7—14 years old children living in the Bakony district, one of the ethnic regions of Hungary. She also examined the sexual maturation of 1118 10—14 years old girls belonging to the surveyed sample, relying upon the secondary sex characters (stage of development of the mamma, pubic- and axillary hair), as well as upon the time when menarche took place. In the present paper she intends to examine the relationship between maturation and physique by means of the age at menarche and the somatotype.

Somatotyping was done with HEATH—CARTER'S (1967) method.

The age at menarche of the already menstruating girls was determined with an accuracy of the specific months.

In the course of statistical analysis also the values of the χ^2 test and of the correlation coefficient were calculated besides the usual parameters.

Results of the examination and their evaluation

So that the relationship between maturation and physique could be studied the author separated the somatotypes of the girls arranged in half-yearly

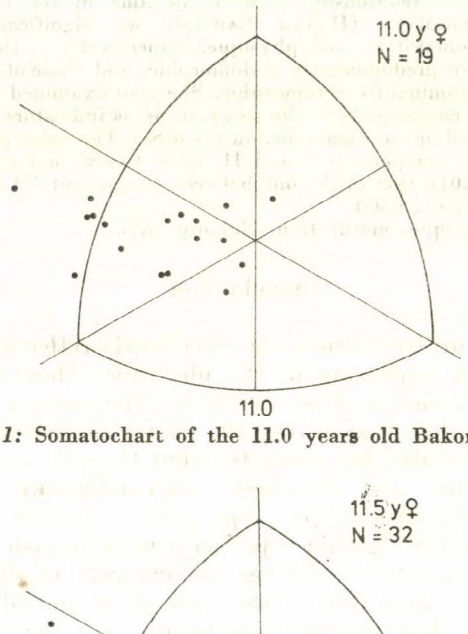


Fig. 1: Somatochart of the 11.0 years old Bakony girls

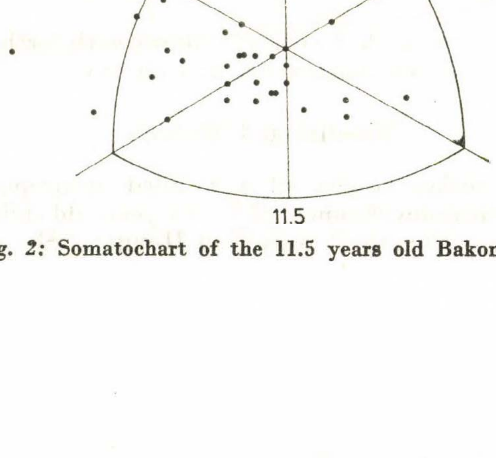


Fig. 2: Somatochart of the 11.5 years old Bakony girls

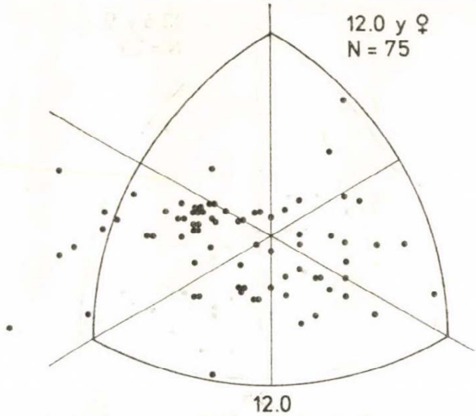


Fig. 3: Somatochart of the 12.0 years old Bakony girls

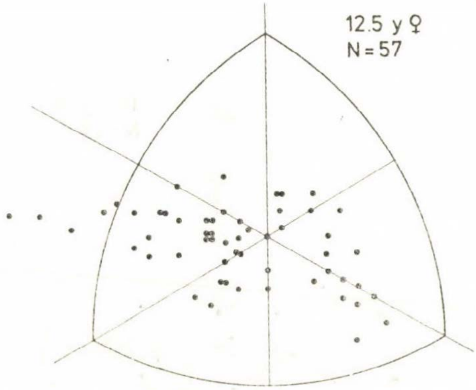


Fig. 4: Somatochart of the 12.5 years old Bakony girls

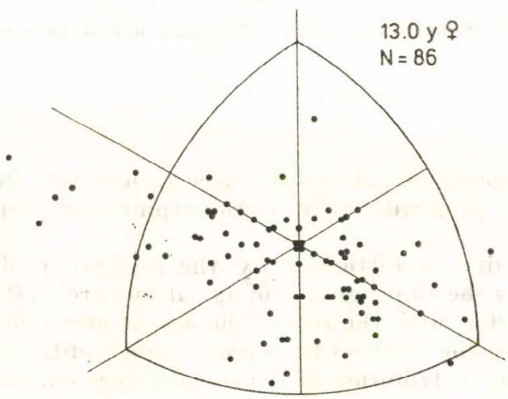


Fig. 5: Somatochart of the 13.0 years old Bakony girls

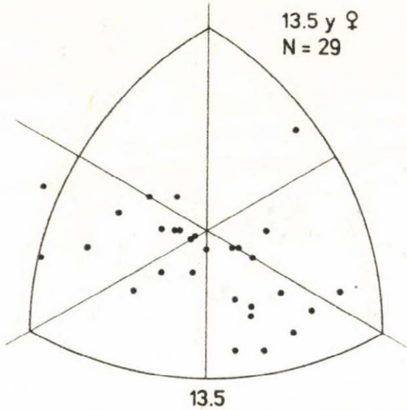


Fig. 6: **Somatochart of the 13.5 years old Bakony girls**

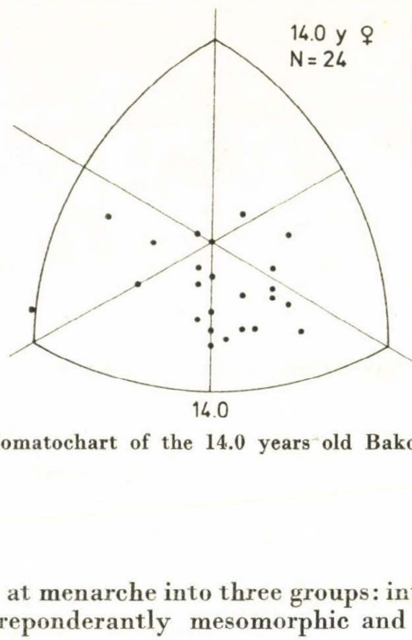


Fig. 7: **Somatochart of the 14.0 years old Bakony girls**

categories by their ages at menarche into three groups: into those of preponderantly endomorphic, preponderantly mesomorphic and preponderantly ectomorphic physique.

Although perspicuity is disturbed by the inequality of the numbers of the girls representing the single groups of age at menarche, it is clearly observable in the Figures that with the rise of the age at menarche the distribution of the somatotypes in the fields of the somatogram is different (Figures 1—7). The differences in the distribution of the somatotypes examined as a function of the ages at menarche are most expressively shown by the relative frequencies presented in Table 1 and Fig. 8.

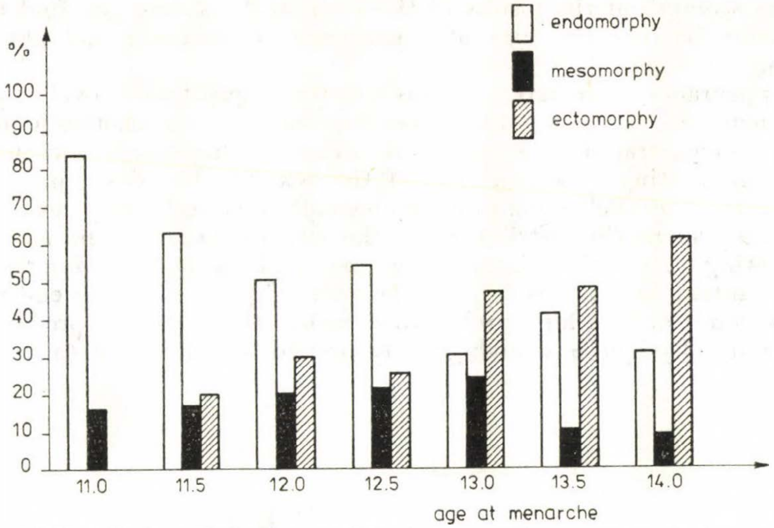


Fig. 8: **Distribution of physiques of the Bakony girls according to the age at menarche**

Table 1

Distribution of predominance of the three components in Bakony girls

Menarche age-groups	Groups of physique					
	Endomorphic		Mesomorphic		Ectomorphic	
	n	%	n	%	n	%
11.0	16	84.21	3	15.79	—	—
11.5	19	63.33	5	16.67	6	2.00
12.0	38	50.67	15	20.00	22	29.33
12.5	30	53.57	12	21.43	14	25.00
13.0	25	29.76	20	23.81	39	46.43
13.5	12	41.38	3	10.34	14	48.28
14.0	7	30.43	2	8.70	14	60.87

Similarly to the survey results of Kralj-Čerček (1956) and Tanner (1964) the Figures and the data of Table 1 reflect the tendency that the physique of the girls maturing earlier is endomorphic with the highest frequency, on the other hand, the ones who reach maturity later are represented in greatest proportion in the group of the ectomorphic physique. Subjecting the data of Table 1 to further analysis, it can also be found that with the rise of the age at menarche the relative frequency of the girls of ectomorphic physique is increasing, while the one of those of endomorphic physique is becoming lower.

For statistically verifying the fit of the age at menarche and somatotype, the author carried out the χ^2 test:

$$\chi^2 = 70.407 \quad f = 22$$

On the strength of the results of the statistical test one can find that the relationship between the time of appearance of menarche and physique is significant on a $p < 0.001$ level.

The appearance of menarche means a definite qualitative level of physical development. As a next step, the author wanted to clarify whether a difference could be demonstrated between the physiques of the sexually developed, already menstruating girls and that of the sexually less developed, not yet menstruating ones, belonging in chronologically identical age-groups. Table 2 and Fig. 9 present the distribution of the already menstruating and not yet menstruating girls within the three groups of physique, grouping them with half-year intervals. The trend that the girls of predominantly endomorphic physique mature, to a high probability, earlier than those of predominantly ectomorphic physique is unambiguously proved also by the data of Table 2

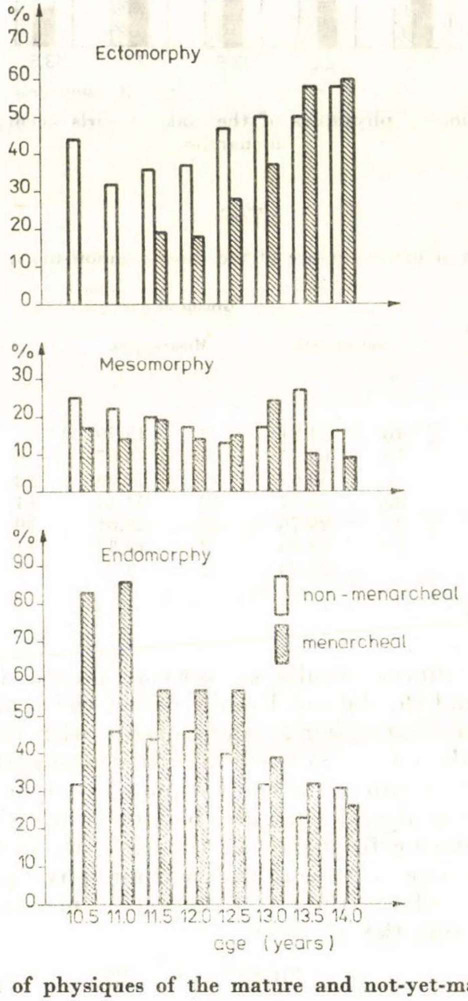


Fig. 9: **Distribution of physiques of the mature and not-yet-mature Bakony girls**

Table 2

Distribution of the physiques of the mature and not yet mature girls of identical age

Age-groups		Groups of physique					
		Endomorphic		Mesomorphic		Ectomorphic	
		n	%	n	%	n	%
10.5	Non-menarcheal	40	31.75	31	24.60	55	43.65
	Menarcheal	5	83.33	1	16.67	—	—
11.0	Non-menarcheal	61	46.21	30	22.73	41	31.06
	Menarcheal	6	85.71	1	14.29	—	—
11.5	Non-menarcheal	59	44.03	27	20.15	48	35.82
	Menarcheal	13	61.90	4	19.05	4	19.05
12.0	Non-menarcheal	48	46.15	18	17.31	38	36.54
	Menarcheal	25	67.57	5	13.51	7	18.92
12.5	Non-menarcheal	34	40.00	11	12.94	40	47.06
	Menarcheal	30	56.60	8	15.09	15	28.31
13.0	Non-menarcheal	15	32.61	8	17.39	23	50.00
	Menarcheal	32	38.55	20	24.10	31	37.35
13.5	Non-menarcheal	6	23.08	7	26.92	13	50.00
	Menarcheal	38	32.20	12	10.17	68	57.63
14.0	Non-menarcheal	5	26.32	3	15.79	11	57.89
	Menarcheal	38	31.41	11	9.09	72	59.50

The author examined, further, the relationship between the three components of somatotype each as an indicator of physique (component I as indicator of fatness and fullness, respectively; component II as indicator of the robusticity of the skeletal muscles, as well as component III as indicator of linearity) and age at menarche as indicator of sexual maturity.

The values of the correlation coefficients between factors I and II with age at menarche, were $r = -0.30 \pm 0.2$ and $r = -0.30 \pm 0.1$, respectively ($p < < 0.001$). Relying upon the sign of value r this linear correlation is negative, which means that the fuller the physique and the more robust the muscles and bones are, respectively, the earlier the maturity. The result of the correlation analysis conducted between factor III as indicator of linearity and age at menarche: $r = +0.20 \pm 0.1$ ($p < 0.05$) is in accordance with this: a more slender physique is generally associated with later sexual maturation.

To sum up: there is a statistically verifiable and demonstrable connection between age at menarche and physique. The distribution of the girls of somatotypes of earlier and later maturity is different. There is a trend of shifting from the endomorphic fields toward the ectomorphic ones to be observed with the appearance of maturity at a later age.

Between the components of somatotype and age at menarche a significant correlation was observed: an earlier maturation of the girls who are more fat, more full and more robust as to the skeletal muscles is significantly more probable than of those of slender physique.

REFERENCES

Broms, J.—Hebbelinck, M.—Van Gheluwe, B. (1977): Early and late maturity in Belgian boys, 6 to 13 years of age and its relation to body type. — *In:* Eiben, O. G. (Ed.): *Growth and Development; Physique.* Symp. Biol. Hung. *20;* 399—406. Akadémiai Kiadó, Budapest.

Carter, J. E. L. (1972): *The Heath — Carter somatotype method.* — San Diego State College, San Diego.

Kralj-Čerček, L. (1956): The influence of food, body build and social origin on the age at menarche. — Human Biology *28;* 393—406.

Tanner, J. M. (1962): *Growth at Adolescence.* — Blackwell, Oxford—Edinburgh.

Author's address: B. Dr Bodzsár Éva.
Dept. Anthropology, Eötvös Loránd University
H-1088 Budapest, Puskin u. 3.
Hungary

Anthrop. Közl. *24;* 31. 1980.

BODY MEASUREMENTS OF PATIENTS WITH STREAK GONADS AND THEIR BEARING UPON THE KARYOTYPE

by P. BŐSZE, O. G. EIBEN and J. LÁSZLÓ

(Cytogenetic Laboratory, Clinic of Obstetrics and Gynaecology, Postgraduate Medical School, Budapest, Hungary; Department of Anthropology, Eötvös Loránd University, Budapest, Hungary)

Abstract. Anthropometric and cytogenetic investigations were carried out in 32 patients with streak gonads. The physique of the patients was delineated according to their chromosomal complements. For the possible localization of the determinants of the X chromosome for the physique the following conclusions were drawn.

For normal height both the short and the long arm of the X chromosome are essential.

The short arm of the X chromosome contains determinants which, if deleted, result in a high weight to height ratio i.e. proportionally heavier weight. The weight to height ratio is also shifted to the left in deleted Xq cases, yet to a lesser extent.

Determinants are present in both the short and the long arms of the X chromosomes which are involved in the proportional development of the ratio of the limbs to trunk. In all deleted X cases the limbs were shorter.

Duplication of the long arm of the X chromosome does not compensate for the loss of the short arm.

Key words: physique, body measurements, streak-gonad-patients, X-chromosome abnormalities.

The complete paper was published in *Human Genetics 54;* 355—360. (1980).

Authors' addresses: Dr. BŐSZE PÉTER
Prof. Dr. LÁSZLÓ JÁNOS
Clinic of Obstetrics and Gynaecology, Postgraduate Medical School
H-1135 Budapest, Szabolcs u. 33—35.
Hungary

Dr. EIBEN OTTÓ
Dept. Anthropology, Eötvös Loránd University
H-1088 Budapest, Puskin u. 3.
Hungary

Anthrop. Közl. *24;* 33—37 1980.

SOME CONNECTIONS OF THE NUTRITIONAL CUSTOMS WITH BODY DEVELOPMENT

(Preliminary communication)

by J. BUDAY, L. CSABAY, V. GÖLLESZ, G. HEGEDŰS and L. RENDI

(Department of Pathophysiology, Training College for Teachers of Handicapped Children, Budapest, Hungary)

Abstract. The nutritional customs of 8000 school children (aged 7—14 years) partly from primary school and partly from auxiliary school were examined. The children belong to 8 areas of Hungary: Budapest, Győr, Szombathely, Pécs, Szolnok, Szeged, Miskolc, Debrecen. Stature, body weight, chest circumference, skinfold thicknesses and circumferences of the extremites of 4000 of these children were measured. 2500 girls were asked about the beginning of menarche, if they were older than 9 years of age.

This paper presents the growth and development of primary and auxiliary school children as referred to their nutritional customs. The results are compared to data of earlier examinations of body development conducted in certain areas.

Key words: growth and development, body measurements, nutrition, primary school children, auxiliary school children.

A great number of authors studied the connections of nourishment and body development. First of all the influence of certain kinds of nourishment was examined. The connections between the nutritional customs and the body development are less known.

BACHMANN (1976) found considerable differences between the nutritional customs of the primary school and auxiliary school children in the Federal Republic of Germany.

There are two scientific teams as an international cooperation partly in Hungary, partly in Czechoslovakia which examined this problem, completing the survey with measurements of the body development. The work was performed in April and May, 1977. The fixation of this time was indispensable because the food-offer had to be taken into consideration at the comparison of the results.

If we have to study the nutritional customs, the regional differences cannot be neglected. Therefore, the examinations in Hungary were performed in eight areas, such as Budapest (N = 2842), Győr (N = 730), Szombathely (N = 642), Pécs (N = 747), Szolnok (N = 754), Szeged (N = 708), Miskolc (N = 739), Debrecen (N = 783), altogether 7945 children. These children were asked according to the *Bachmann's-questionary*. Nearly half of them were primary school children and the other half were auxiliary school ones. The auxiliary school is a special educational institution organized for mentally retarded children. Under the prescription children with mild mental retardation are introduced in the auxiliary schools in Hungary, and their IQ is 0.70—0.50.

The anthropometric measurements were performed nearly 4000 children. 17 body measurements were examined. Eventually, the girls older than 9 were asked about their menarche.

The main intention of the present work is the description of the differences in the nutritional customs and the body development in the mentioned pupils above. The results by the body measurements of the children belonging to the most populated area (Budapest), and by their choosing some kinds of food are shown. Table 1 shows the choice of certain sorts of food (first column: "like") or the refusal of these (second-column: "does not like") based on the §5 of the Bachmann's-questionary. These sorts of food were arranged in the decreasing order of the number of choices among the primary school children. The order of the auxiliary school children differs from this order.

Table 1

Choosing food (per cent)

Food	Primary school children			Auxiliary school children		
	Like	Does not like	No decision	Like	Does not like	No decision
Fruit	8.8	0.8	3.5	8.7	0.9	5.4
Meat	8.0	3.5	7.1	8.0	4.0	5.0
Milk	7.9	4.2	5.1	8.7	3.8	6.2
Potatoes	7.9	4.3	5.0	7.5	5.8	4.1
Chicken	7.9	4.5	4.6	7.8	4.4	6.0
Leguminous	7.5	5.8	6.2	7.2	7.1	6.2
Eggs	7.3	6.3	8.1	7.5	6.0	4.7
Cheese	7.0	7.5	8.6	7.0	8.0	6.0
Fish	6.9	8.2	7.0	6.4	9.8	9.1
Rice	6.7	9.0	8.1	6.4	10.2	8.5
Noodles	6.4	9.9	9.0	6.4	10.1	8.5
Groats	6.3	10.6	8.3	6.6	9.3	9.6
Vegetables	6.0	11.8	8.5	6.9	7.7	10.7
Curd	5.5	13.5	10.9	5.6	13.1	9.9

$\lambda = 1.90 \quad 0.05 > P > 0.01$

The data of this table are examined with one-pattern *Kolmogorov—Smirnoff-test.* There is no significant difference between the primary and the auxiliary school children, when the limit of significance is fixed up on a 0.01 level, in accordance with BACHMANN. Further calculations in connection with the choosing of certain kinds of food in some cases (e.g. vegetables, fish, eggs) the chi square test, gave significant differences still on a 0.001 level.

Now, authors should like to demonstrate the average of the most important body measurements and their deviation by age.

Authors explain the problem by means of Figures 1, 2 and 3 as follows: Children aged 15 years are too old to go to both school types. Very seldom such pupils are to be found in the primary school (there are only 7 in the whole sample), but in auxiliary schools they are numerous.

The age of menarche is shown by arrows, and is $m = 12.42 \pm 0.10$ years in the primary school girls and $m = 12.37 \pm 0.15$ years in the auxiliary school girls.

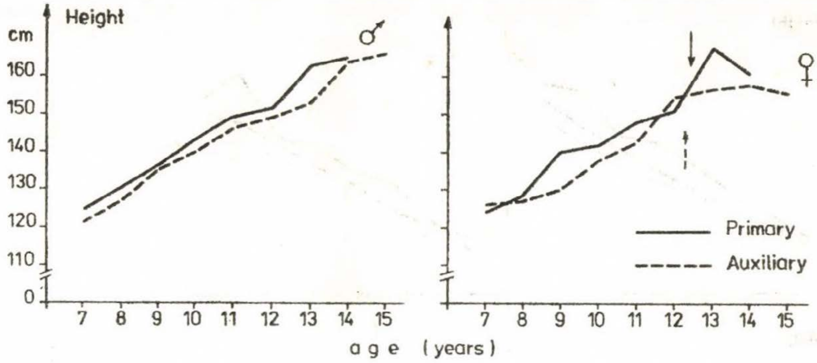


Fig. 1: **Height of primary school and auxiliary school children**

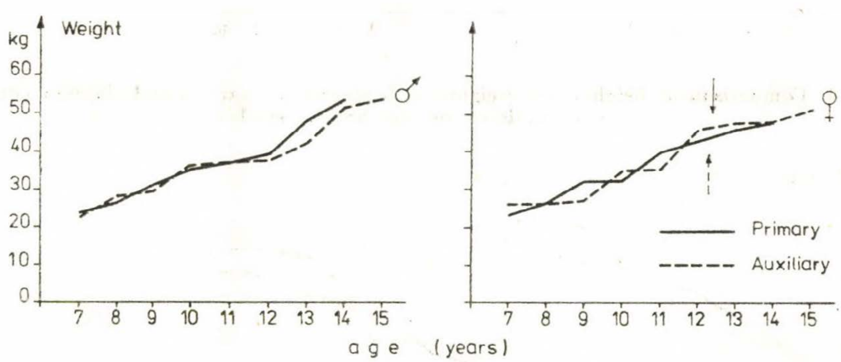


Fig. 2: **Weight of primary school and auxiliary school children**

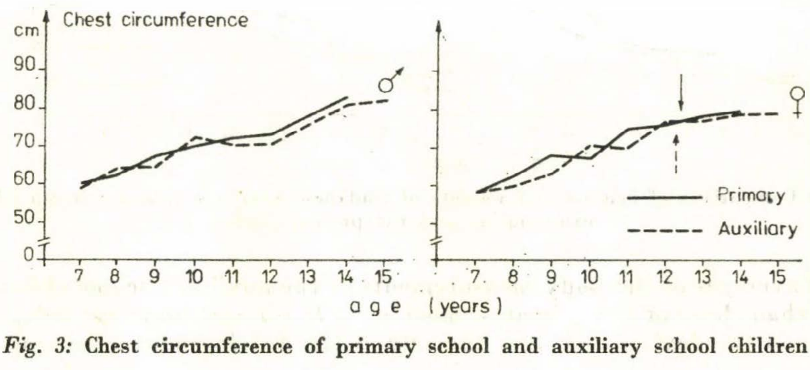


Fig. 3: **Chest circumference of primary school and auxiliary school children**

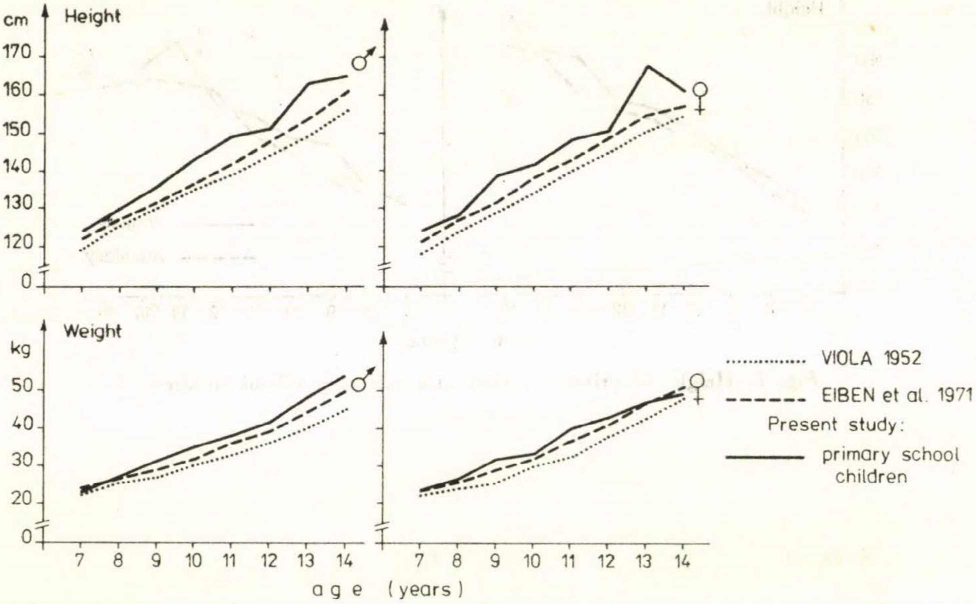


Fig. 4; **Comparison of heights and weights of Budapest primary school children (Previous examinations and the present study)**

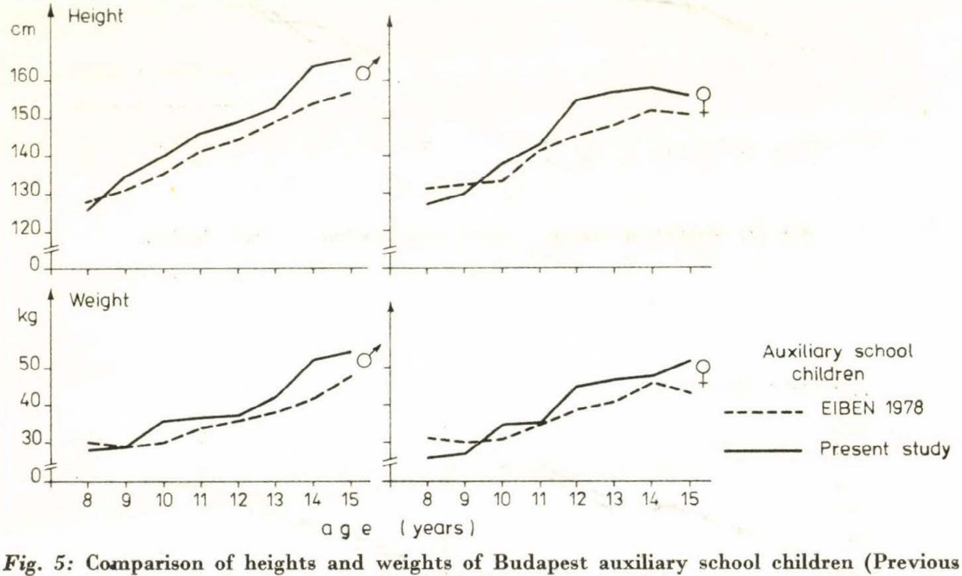


Fig. 5: **Comparison of heights and weights of Budapest auxiliary school children (Previous examination and the present study)**

The averages of the body measurements of the auxiliary school children are lower than those of the primary school ones. It is important that beloging the figures of the deviation of age, the rate of the development belonging to the figures also seem to be dissimilar. This fact is confirmed by the study of proportional analysis of these measurements.

The comparison of the previous examinations performed in Budapest with authors' results is presented in Figures 4 and 5 containing height and weight (EIBEN et al. 1971, VIOLA 1952). The tendency is unambigous that these two measurements show higher averages in the latest examinations. A similar tendency in the data given by auxiliary school children was found.

The auxiliary school children, compared with the primary ones are underdeveloped, and probably also the rate of their development is different. Authors supposed that first of all social factors could be behind this backwardness. The most important among them are connected with nourishment. Among the social factors affecting nourishment also the nutritional customs have a part. However, there are differences as to the ingestion of certain kinds of foods. Further on, it is necessary to perform a more exact analysis in respect of body development. Such calculations are under way.

REFERENCES

BACHMANN, W. (1976): *Ernährungsverhalten von Schülern.* — Food Press Internat. Verlag, Obernburg/Main.

EIBEN, O. (1978): A testi fejlettség vizsgálata. — *In:* CZEIZEL, E.—LÁNYINÉ ENGELMAYER, Á.—RÁTAY, Cs. (Eds): *Az értelmi fogyatékosság kóreredete a „Budapest vizsgálat" tükrében,* pp. 86—91. Medicina, Budapest.

EIBEN, O.—HEGEDŰS, G.—BÁNHEGYI, M.—KIS, K.—MONDA, M.—TASNÁDI, I. (1971): *Budapesti óvodások és iskolások testi fejlettsége, 1968—1969.* — Budapesti Fővárosi KÖJÁL, Budapest.

VIOLA, I. (1952): Fejlődési táblázatok. — *In:* KAROSSA-PFEIFFER, J.—MELLY, J. (Eds): *Az iskolaorvos zsebkönyve.* — Medicina, Budapest.

Authors' address: Dr. BUDAY JÓZSEF
Dr. CSABAY LÁSZLÓ
Dr. GÖLLESZ VIKTOR
Dr. HEGEDŰS GYÖRGY
Dr. RENDI LÁSZLÓ
Training College for Teachers of Handicapped Children
H-1071 Budapest, Bethlen tér 2.
Hungary

Anthrop. Közl. 24. 39—44. 1980.

SIZE, SHAPE AND BODY PROPORTION OF YOUNG BASKETBALL PLAYERS

by E. Chovanová and L. Zapletalová

(Research Institute, Faculty of Physical Education, Comenius University, Bratislava, Czechoslovakia)

Abstract. The study deals with somatometric, somatotypologic and proportional characteristics of young Czechoslovakian basketball players. The examined groups consisted of boys and girls belonging to three age groups (from 13 to 18 years) who were divided according to specialization into guards, forwards and centres. The results suggest that even in young basketball players specialized in the posts mentioned above the size of the body and of the extremities differ considerably. According to the somatotypologic analysis, the guards display the highest mesomorphy and the centres the highest ectomorphy. There are small differences in body proportionality between guards, forwards and centres.

Key words: physique, body measurements, body proportion, somatotype, basketball players.

Introduction

It is for the most part studies dealing with the observation of the body build of the best basketball players, representative of different countries that appear in the literature. The anthropometric, functional and motor indices of young basketball players were observed by Vank et al. (1974), Sekkin and Krotov (1975), Dobry (1967) and Haley (1974).

Our contribution is concerned with the characteristics of some body parameters, with the somatotypologic analysis and proportional characteristics of young basketball players.

Material and Methods

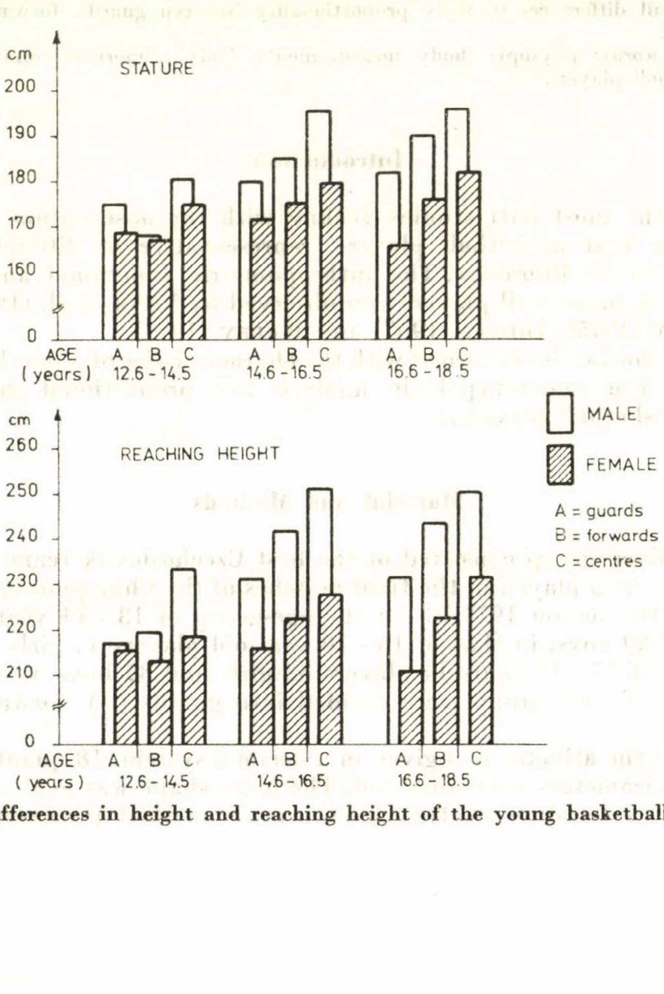
The examined group consisted of the best Czechoslovak teams of different age-groups, which played in the final matches of the Championship of Czechoslovakia in the season 1977|78. In the age-group of 13—14 year-old players 27 girls and 29 boys, in that of 15—16 year-old players 47 girls and 54 boys and in that of 17—18 year-old players 32 girls and 37 boys were examined. The players of each group were divided into guards (A), forwards (B) and centres (C).

The age of the athletes was given in a decimal system. 18 quantitative morphological parameters were observed. The body shape was evaluated somatotypologically, according to Heath—Carter's method (Carter 1975), and the results were elaborated statistically according to Ross et al. (1974). The proportionality of the body parameters of the observed groups was evaluated according to EIBEN et al. (1976).

Results

Body size

From the results of the observed length measurements of the body and extremities (standing height, sitting height, reaching height, length of the arms and legs) and body weight of young basketball players it appears that in all mentioned parameters, in boys and girls of each age-group the guards display the lowest values. The values of the forwards are higher, and the highest values are to be found among the centres. In girth measurements of the extremities the results were the same, except for the 15—16 and 17—18 year-old girls, where the highest values were presented by the forwards. The significance of the differences in average numbers of the mentioned parameters is demonstrated in the Table 1. The greatest differences can be found between guards and centres (A:C), smaller ones between forwards and centres (B:C), especially in standing height, weight, reaching height and length of the lower extremities (the differences in standing and reaching height are presented in the Fig. 1).



1 *Fig. 1:* **Differences in height and reaching height of the young basketball players**

Table 1

Results of the *t*-test between mean anthropometric parameters of young basketball players, according to specialization

Male	13—14			15—16			17—18		
	A:B	A:C	B:C	A:B	A:C	B:C	A:B	A:C	B:C
Stature	2.64	3.73*	3.90*	2.36	7.47*	5.54*	4.47*	5.22*	2.72
Weight	—	3.54*	2.53	—	6.47*	5.97*	—	3.29*	—
Reaching height	—	3.34*	2.87	3.46*	6.47*	3.05*	4.77*	5.42*	2.44
Upper extr. length	—	3.25*	3.06*	2.16	4.22*	3.29*	3.03*	3.12*	—
Sitting height	—	—	2.46	—	4.10*	4.01*	2.27	2.46	—
Lower extr. length	—	3.79*	3.16*	2.18	6.06*	3.55*	2.09	2.54	—
Arm girth	2.98*	3.00*	—	—	2.28	2.40	—	2.22	—
Calf girth	—	—	—	—	2.97	3.48*	—	—	—

Female	13—14			15—16			17—18		
	A:B	A:C	B:C	A:B	A:C	B:C	A:B	A:C	B:C
Stature	—	3.07*	3.59*	—	4.30*	2.30	3.97*	7.13*	2.39
Weight	—	2.43	3.33*	—	2.97	—	2.65	4.18*	—
Reaching height	—	—	—	2.11	4.34*	2.12	3.65*	7.18*	3.03*
Upper extr. length	—	—	2.71	—	3.88*	—	3.36*	6.53*	—
Sitting height	—	—	—	—	2.70	2.79	3.45*	4.22*	—
Lower extr. length	—	—	2.65	3.01*	3.06*	—	3.10*	7.93*	3.64*
Arm girth	—	—	—	—	—	—	—	—	—
Calf girth	—	—	2.54	—	—	—	—	—	—

* = t significant at 0.01 level of confidence; without * *t* significant at 0.05 level of confidence
A: guards, B: forwards, C: centres

Body shape

Founded on the somatotypologic analysis of the boys and girls (Fig. 2) it can be said that it is mostly the guards who have the greatest mesomorphic component, i.e. they have the greatest amount of LBM. The greatest ectomorphic component appears among the centres, i.e. they display the longest body segments.

The somatotype of 13—14-year-old boy guards and forwards is in the central sector; centres are balanced ectomorphs. The girls are in the sector of endomorphic mesomorphs.

The somatotype of 15—16-year-old boy guards is in the sector of mesomorph–ectomorph, the forwards and centres are mesomorphic ectomorphs. The girls' somatotype is in the central sector, but the girls guards have the highest

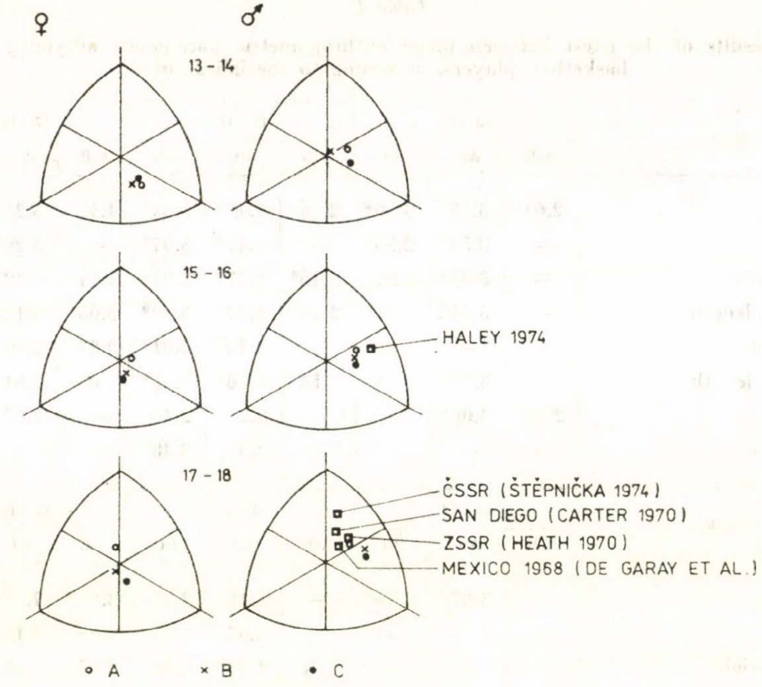


Fig. 2: **Somatotypes of the young basketball players**

mesomorphic components. The somatotype of 15-year-old basketball players of the Bonita Vista Junior High School which was observed by HALEY (1974) is placed in the same sector as that of authors' group, but the American boys have less subcutaneous fat.

The 17—18-year-old boy guards are in the mesomorph–ectomorph sector, the forwards and centres are mesomorphic ectomorphs. The girl guards and forwards are in the central sector, and the girl centres are endomorphic ectomorphs.

The adult basketball players: representatives of the U.S.S.R., San Diego, Czechoslovakia and the participants of the Olympic Games in Mexico have higher and dominant mesomorphic components.

The differences in mean SDD between the guards, forwards and centres are not statistically important.

Body proportion

According to the proportional z-scores (Fig. 3) the greatest differences are to be found in the age-group of the 13—14-years old with the boys and in that of the 17—18-years old with the girls.

We can state in general that except for the two mentioned groups there are small differences in body proportions of the young basketball players, if they are standardized on the same body height.

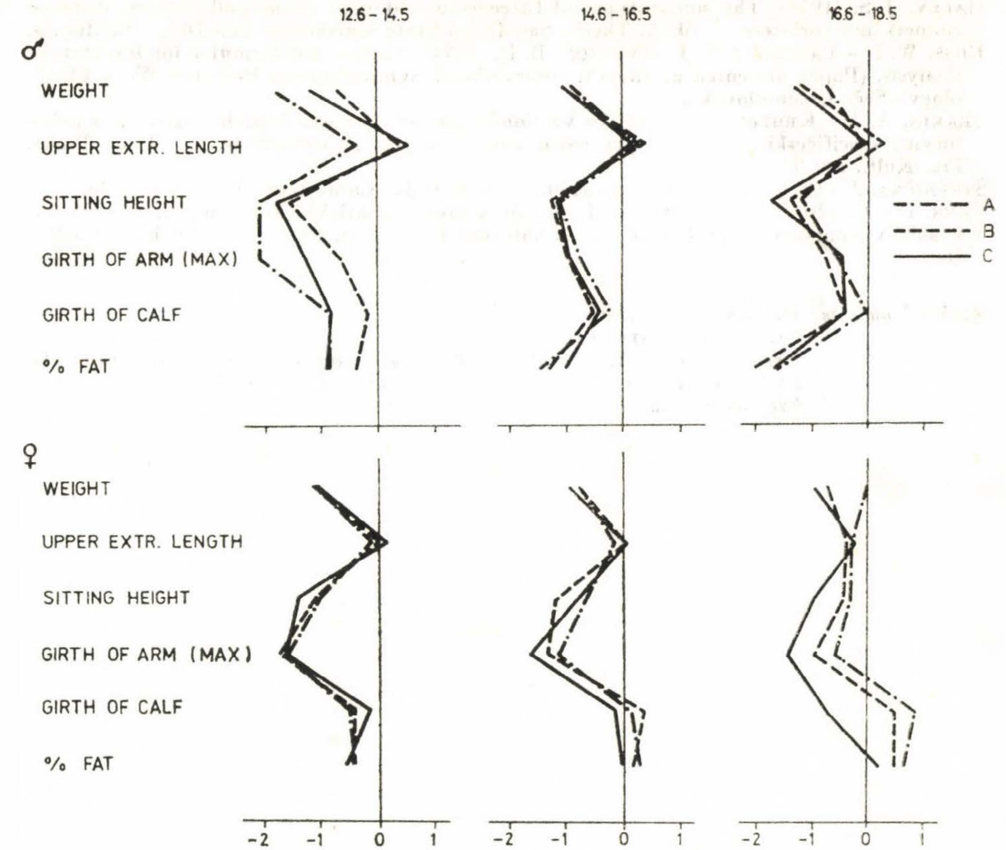


Fig. 3: Proportional z-scores of the young basketball players

Conclusion

Results presented above suggest that even in young basketball players of any specialization, body end extremity sizes differ considerably. According to the somatotypologic analysis, the guards are more mesomorphic and the centres more ectomorphic.

REFERENCES

Carter, J. E. L. (1970): The somatotypes of athletes — A review. Human Biology, *42;* 535—569.

— (1975): *The Heath — Carter somatotype methode* — San Diego State University, San Diego, California.

— (1978): The somatotypes of olympic athletes. (A paper presented at the XXI. World Congress of Sports Medicine, Brasilia, Brazil, Sept. 8—12.)

Dobrý, L. (1967): Longitudinální sledování vztahu basketbalové výkonnosti, tělesné zdatnosti a některých antropometrických ukazatelů u 10—14 letých basketbalistů (chlapců a děvčat). — Metodický dopis ÚV ČSTV Praha. *3;* 220—222.

Eiben, O. G.—Ross, W. D.—Christensen, W.—Faulkner, R. A. (1976): Proportionality characteristics of female athletes. — Anthrop. Közl. *20;* 55—67.

HALEY, J. S. (1974): The somatotypes of fifteen-year-old male basketball players, distance runners and sprinters. — M. A. Thesis. San Diego State University, San Diego, California.
ROSS, W. D.—CARTER, J. E. L.—WILSON, B. D. (1974): Tactics and formulae for somatotype analysis. (Paper presented at the VI. International Symposium on Pediatric Work Physiology, Seč, Czechoslovakia.)
SEKKIN, A. A.—KROTOV, V. A. (1975): Vzaimnosvjaz antropometričeskich priznakov s nekotorymi specifičeskimi testami pri issledovanii junnych basketbolistov. — Teor. Prakt. Fiz. Kult., *50;* 41.
ŠTĚPNIČKA, J. (1974): Typologie sportovců. — Acta Univ. Carol. Gymnica, *10;* 67—90.
VANK, L.—DRAŽIL, V.—MATĚJKOVÁ, J. (1974): Některé somatické a funkční zhaky sportovců vysoké výkonnosti v různých věkových kategóriích. — Teor. Praxe. Těl. Vých., *22;* 560—566.

Authors' address: Dr. EVA CHOVANOVÁ
Dr. L. ZAPLETALOVÁ
Research Institut, Faculty of Physical Education Comenius University
88621 Bratislava—Lafranconi, nábr. arm. gen. L. Svobodu 9.
Czechoslovakia

Anthrop. Közl. *24.* 45–54. 1980.

A MODIFICATION OF SHELDON'S ANTHROPOSCOPIC SOMATOTYPE TECHNIQUE

by A. CLAESSENS, G. BEUNEN, J. SIMONS, P. SWALUS, M. OSTYN, R. RENSON and D. VAN GERVEN

(Institute of Physical Education, Catholic University Leuven, Heverlee, Belgium; Institute of Physical Education, Catholic University Louvain, Louvain-la-Neuve, Belgium)

Abstract. The purpose of this study was to find out a practical, fairly easy objective and valid somatotype technique which could be used in a six year cross sectional and longitudinal study.

132 young men from 17 to 19 years of age were independently somatotyped according to both methods (photometric and photoscopic) of Sheldon, the method of Parnell and that of Heath–Carter. Besides statistical characteristics obtained for the three components according to the four methods, the correlations between the components of the same type and the intercorrelations between the three components in each method were also calculated.

A very high agreement was found between the two Sheldon techniques, on the one hand and between the Parnell and Heath–Carter methods, on the other hand. — Fairly large discrepancies were found between both Sheldon techniques and the Parnell and Heath–Carter methods for mesomorphy, although for the other two components the methods were in good agreement.

For testing which of the four methods gives an estimation of the athletic build (bone and muscle development), the correlations between mesomorphy ratings and 24 motor ability tests were calculated.

The mesomorphy ratings according to both Sheldon techniques were significantly correlated with 16 of 24 motor tests, whereas only 8 and 4 significant correlations were found for the Parnell and the Heath–Carter methods, respectively.

On basis of these findings a modified anthroposcopic Sheldon method was developed whereby the tables of Parnell and Heath–Carter, respectively, were used for a first estimation of endomorphy and ectomorphy, and whereby the final rating was based on the anthroposcopic atlas technique developed by Sheldon. Before using this new technique in the six-year-long study, we compared it with the original photometric Sheldon method. The correlations between the components rated according to these methods ranged from 0.84 to 0.93. The means of the components did not differ significantly, except for endomorphy. This leads us to the conclusion that the proposed method is a fairly good technique for estimating the somatotype.

Key words: physique, somatotype, Leuven somatotype method, anthroposcopic-photometric method of SHELDON, anthroposcopic atlas-technique of SHELDON, anthropometric method of PARNELL, anthropometric somatotype method of HEATH–CARTER.

Introduction

After SHELDON in 1940, with his work *The Varieties of Human Physique* had caused a real "Copernican" revolution in the ancient world of "dichotomy" and "trichotomy" type classifications, a lot of critiques have arisen against this "Gestalt" typology. These critiques are of a theoretical, practical and methodological kind.

That several simplifications (CURETON 1974, WILLGOOSE 1961) and/or modifications (PARNELL 1954, 1958 DAMON et al. 1962, HEATH 1963, HEATH and CARTER 1966, 1967, MUNROE et al. 1969) of SHELDON's method have been proposed is no wonder.

In 1967, research workers of the Department of Physical Education (K.U. Leuven) planned a project to study the physical fitness of 12 to 19 year-old Belgian boys. This study is called "The Leuven Boys' Growth Study" (SIMONS et al. 1974).

Two phases, a pilot study and a main study can be distinguished in it.

During the academic year 1967—1968 the pilot study (SIMONS et al. 1971) was carried out on a limited group of subjects. The main topic of this pilot study was the selection of the variables to be used in the main study afterwards.

The purpose of including the *Somatotype* in the study was to get information about the following questions:

1. does somatotype change during adolescence in healthy boys?
2. can adult physique be fairly accurately predicted from preadolescent physique?

Also the collected data on physique type should allow us:

1. to compare the somatotype distribution of the different age groups with those of other countries and other age groups,
2. to study the relationship between somatotype and physical fitness i.e. motor test results, body dimensions maturation, sport participation and socio-cultural variables.

The aim of the pilot study was to find out a practical, fairly easy, objective and valid somatotype technique which could be used in the six-year cross-sectional and longitudinal study. In this paper we will discuss this technique.

Procedures

Subjects

The subjects who participated in the pilot study were students of the St. Pieter college at Leuven.

In the present study, 132 subjects from 17 to 19 year of age are investigated.

Methods and variables

Of all subjects a standardized somatotype photograph (front-sideback view) was taken (DUPERTUIS and TANNER 1950).

The anthropometric measurements which are necessary for both the *Parnell-method* and the *Heath—Carter Anthropometric Somatotype-method* were also taken (PARNELL 1958, HEATH and CARTER 1967).

Of all the testees the somatotype was defined according to each of the following four techniques:

1. The anthroposcopic — photometric method of SHELDON 1940 (SHELDON et al. 1970)

(ENS — MES — ECS)*

2. The anthroposcopic Atlas — techniques of SHELDON — 1954 (SHELDON et al. 1954)

(ENE — MEE — ECE)*

3. The anthropometric method of PARNELL (PARNELL 1954, 1958)

(ENP — MEP — ECP)*

4. The Heath—Carter Anthropometric Somatotype Method (HEATH and CARTER 1967)

(ENH — MEH — ECH)*

The somatotype ratings according to these four methods were carried out by one of the authors (P.S.) who has experience in the field of somatotyping (SWALUS 1966).

Results

Comparison of the somatotype methods investigated

For the comparison between the somatotype methods of SHELDON — 1954, PARNELL and HEATH—CARTER we refer to the article of SWALUS and his collaborators (SWALUS et al. 1970).

In the following tables a survey of the results of the comparison among these three techniques is given together with the comparison between these three methods and the anthroposcopic-anthropometric Sheldon-technique. This latter comparison was not discussed in the article by SWALUS et al. (1970).

In the first place we are comparing the means of each of the components according to the four methods (Table 1).

All the differences are significant (at a .01 level) except for the differences between endomorphy-ratings according to SHELDON 1940—1954; between ectomorphy-ratings according to SHELDON — 1940 and PARNELL; and between ectomorphy-ratings according to SHELDON — 1954 and HEATH—CARTER.

Table 2 shows the correlations between the same components estimated according to different techniques.

For ectomorphy there is a high agreement between the four methods (r ranged from .82 to .90).

For endomorphy a high correlation is found between both Sheldon-techniques (.90) and between both anthrópometric methods too (.94). For mesomorphy, however, large discrepancies were found between both Sheldon-

* These abbreviations, used in the tables in this article, are standing for:

ENS, MES, ECS: endo-, meso-, ectomorphy, respectively according to the SHELDON method — 1940.

ENE, MEE, ECE: endo-, meso-, ectomorphy, respectively according to the Atlas technique of SHELDON.

ENP, MEP, ECP: endo-, meso-, ectomorphy, respectively according to the method of PARNELL.

ENH, MEH, ECH: endo-, meso-, ectomorphy, respectively according to the method of HEATH—CARTER.

Table 1

Means (M), standard deviations (SD), and t-scores of each of the components (N = 132)

Endomorphy	*M*	*SD*	*t/2*	*t/3*	*t/4*
1. E N S	3.11	1.17	0.00	−3.87+	5.91+
2. E N E	3.11	1.23		−3.66+	8.23+
3. E N P	3.40	0.87			28.59+
4. E N H	2.46	1.07			

Mesomorphy	*M*	*SD*	*t/2*	*t/3*	*t/4*
1. M E S	3.98	1.09	−3.63+	4.73+	2.66+
2. M E E	4.09	1.13		6.60+	4.31+
3. M E P	3.44	0.99			−4.74+
4. M E H	3.61	1.04			

Ectomorphy	*M*	*SD*	*t/2*	*t/3*	*t/4*
1. E C S	3.66	1.24	4.92+	−1.81	6.44+
2. E C E	3.35	1.25		−6.09+	−0.35
3. E C P	3.76	1.28			12.99+
4. E C H	3.37	1.17			

+ = Significant at the .01 level of confidence

Table 2

Correlations between the components of the same type (N = 132)

Endomorphy	*E N E*	*E N P*	*E N H*
E N S	0.90	0.66	0.68
		0.67	0.70
			0.94

Mesomorphy	*M E E*	*M E P*	*M E H*
M E S	0.85	0.46	0.33
		0.45	0.31
			0.92

Ectomorphy	*E C E*	*E C P*	*E C H*
E C S	0.85	0.89	0.90
		0.82	0.82
			0.97

techniques and the methods of Parnell and Heath—Carter (from .31 to .46), although the two Sheldon-techniques on the one hand, and both anthropometric techniques, on the other hand correlate fairly highly.

Intercorrelations between the three components in each method show us the following (see Table 3).

Table 3

Intercorrelations between the three components in each method (N = 132)

SHELDON (1940)		*MES*	*ECS*
	ENS	−0.26	−0.56
	MES	—	−0.55
SHELDON (1954)		*MEE*	*ECE*
	ENE	−0.30	−0.50
	MEE	—	−0.50
PARNELL		*MEP*	*ECP*
	ENP	+0.21	−0.58
	MEP	—	−0.74
HEATH & CARTER		*MEH*	*ECH*
	ENH	+0.44	−0.59
	MEH	—	−0.89

In both Sheldon-methods each component correlates negatively with the other two. In the method of PARNELL and also in the method of HEATH—CARTER endomorphy correlates positively with mesomorphy (.21 and .44 respectively). On the other hand, fairly high negative correlations between mesomorphy and ectomorphy (−0.74 and −0.89, respectively) were found. To test which of the four methods gives the best estimation of the athletic — bone and muscle development — build, the mesomorphy ratings according to different techniques were correlated with 24 ability tests. Table 4 shows that the mesomorphy ratings according to both Sheldon-techniques are significantly correlated with 16 tests, whereas on 8 and 4 significant correlations are found for the Parnell- and the Heath—Carter-methods, respectively.

The analysis of these results permits us to draw the following conclusions (see also SWALUS et al. 1970).

— Both Sheldon-techniques are similar, although the mean scores are different (except for endomorphy).

— The method of PARNELL and the Heath—Carter-method are relatively similar, although the mean scores of the three components are different.

— Both anthropometric techniques may eventually be used in lieu of both Sheldon-methods for the estimation of the third components ectomorphy, at the utmost for the first component endomorphy, but not for the estimation of the second component mesomorphy.

— Mesomorphy according to PARNELL and HEATH—CARTER, in opposition to what appears from both Sheldon-techniques, relates positively to endomorphy, and is highly negatively related to ectomorphy. Also their "second" component ratings show lower correlations with different aspects of physical fitness.

Table 4

Correlations between mesomorphy (4 methods) and 24 motor ability tests (N = 132)*

	MES	*MEE*	*MEP*	*MEH*
Dynamic strength				
— Bent arm hang	*0.39*	*0.35*	0.00	−0.16
— Push ups	*0 56*	*0 59*	*0.41*	*0.27*
— Chins	*0.56*	*0.55*	0.17	0.01
Static strength				
— Hand grip	*0.34*	*0.40*	0.21	0.11
— Medicine ball put	*0.38*	*0.43*	*0.24*	0.17
— Arm pull	*0.37*	*0.45*	*0.35*	*0.30*
Explosive strength				
— Vertical jump	*0.28*	*0.35*	−0.01	−0.11
— Standing broad jump	*0.34*	*0.42*	0.03	−0.08
Dynamic trunk strength				
— Leg lifts	*0.39*	*0.42*	*0.33*	*0.24*
— Leg raiser	0.16	0.17	0.16	0.10
Extent flexibility				
— Sit and reach	*0.36*	*0.36*	*0.33*	*0.29*
— Trunk twist	0.13	0.11	−0.08	−0.16
— Ankle flexibility	0.01	0.04	−0.12	−0.17
Speed of change of direction				
— Dodge run	*−0.41*	*−0.41*	*−0.26*	−0.17
— 50 m schuttle run	*−0.26*	*−0.32*	*−0.27*	−0.18
— Figure-8-duck	*−0.30*	*−0.35*	−0.12	0.00
— 160 m shuttle run	*−0.25*	*−0.29*	*−0.25*	−0.17
— 240 m schuttle run	*−0.29*	*−0.28*	−0.17	−0.08
Limb speed				
— One foot tapping	0.22	0.20	0.20	0.15
— Block transfer	0.01	0.02	−0.02	−0.05
— 2 foot tapping	0.03	0.04	0.08	0.05
— Plate tapping	−0.09	−0.08	0.12	0.13
Balance (visual cues)				
— Stick balance	0.03	0.09	0.14	0.15
Endurance				
— Step test (1')	*−0.25*	*−0.27*	−0.03	−0.12

* The values *in italics* are significant at the .01 level of confidence

Project of a method based upon the Atlas technique of Sheldon

Based upon the results of this comparative study it was decided to develop a system which was essentially a Sheldonian atlas technique but which was also based on the anthropometric techniques of PARNELL and HEATH—CARTER.

A few conditions had to be premised:

a) It had to be a *fairly* easy method

— to estimate a great number of subjects (more than 20.000)

— as easy as possible to learn (several observers).

b) It had to be a method as *objective* as possible.

c) It had to be a *valid* method which could estimate the three compiled components of constitution (in a "Sheldonian"-like sense).

These conditions observed and with the results of the comparison in mind the Atlas-technique of SHELDON was chosen with the following modifications:

— a first estimate of endomorphy is based upon the sum of three skinfolds according to the data reported by PARNELL (1957).

— a first estimate of ectomorphy is nased upon the reversed ponderal index $\left(\text{height}/\sqrt[3]{\text{weight}}\right)$ according to the data reported by HEATH and CARTER (1966).

— with these first ratings in mind we turn to the standard photos of the Sheldon Atlas (SHELDON et al. 1954). These photographs (age group 16—24) are arranged on a somatochart. In this way it is fairly easy to situate the subject and to compare him with the surrounding types.

— the final rating is based upon an anthroposcopic estimation using the standard photographs of the Sheldon-Atlas.

Validation of the Leuven method

The Leuven method is a combination of three original somatotype techniques. To validate this adapted method we have compared it with the original photometric Sheldon-technique 1940 (SHELDON et al. 1970).
Table 5 shows the means, standard deviations and *t*-scores of both the Sheldon — 1940. method and the *Leuven method*. The means of the components did not differ significantly, except for endomorphy.

Table 5

Means (M), standard deviations (SD), and t-scores of both the Sheldon method (1940) and the "Leuven" method
(N = 50)

	ENS	ENL	MES	MEL	ECS	ECL
M	3.10	3.37	3.85	3.86	3.67	3.51
SD	1.19	0.98	0.98	0.88	1.24	1.16
t	−2.78*		−0.11		1.88	

* = Significant at the 0.01 level of confidence
ENL, MEL, ECL : Endomorphy, mesomorphy, ectomorphy, according to the "Leuven" method

The correlations between the components rated according to these methods are shown in Table 6.

Table 6

Correlations between the components of the same type of both the Sheldon method (1940) and the "Leuven" method
(N = 50)

	ENL		MEL		ECL
ENS	0.87* (0.82)	*MES*	0.84* (0.75)	*ECS*	0.93* (0.88)

(* = Correlation coefficient corrected for attenuation)

Summary and Conclusions

The purpose of this study was to develop a practical, fairly easy, objective and valid somatotype technique which could be used in a six-year cross-sectional and longitudinal study.

132 young men from 17 to 19 years of age were independently somatotyped according to both methods (photometric and photoscopic) of SHELDON the method of PARNELL and that of HEATH—CARTER. Besides statistical characteristics obtained for the three components according to the four methods, the correlations between the components of the same type and the intercorrelation between the three components in each method, were also calculated. A very high agreement was found between the two Sheldon-techniques on the one hand and between the Parnell- and Heath—Carter-methods on the other hand. For ectomorphy there is a high agreement among the four methods. The ratio height|cube root of weight appears to be a fairly good estimator for ectomorphy.

The correlations obtained between endomorphy according to SHELDON — 1954 and endomorphy according to PARNELL and HEATH—CARTBR (from .66 to .70) confirm the results of DAMON and collaborators between endomorphy and several skinfold measurements ($r = 0.72$) (DAMON et al. 1962).

Fairly large discrepancies, however, were found between both Sheldon-techniques and the Parnell- and Heath—Carter-methods for mesomorphy. For testing which of the four methods gives an estimation of the athletic build (bone and muscle development) the correlations between mesomorphy ratings and 24 motor ability tests were calculated. CURETON also proposed to rate the muscular development and conditions (= mesomorphy); the second gross aspect of "Physique" by means of "feeling" muscles (CURETON 1947 p. 120—122).

The mesomorphy ratings according to both Sheldon-techniques were significantly correlated with 16 of 24 motor tests whereas only 8 and 4 significant correlations, respectively, were found for the Parnell- and the Heath—Carter-method.

Founded on these findings a modified anthroposcopic Sheldon-method was developed whereby the tables of PARNELL and HEATH—CARTER, respectively, were used for a first estimation of endomorphy and ectomorphy and whereby the final rating was based on the anthroposcopic atlas technique developed by SHELDON.

Before using this new technique in the six-year-long study, we compared it with the original photometric Sheldon-method. The correlations between the components rated according to these methods ranged from 0.84 to 0.93. The means of the components did not differ significantly, except for endomorphy.

The more objective anthropometric "phenotype" techniques were not withheld to rate the somatotype, ultimately, because they show:

1. a greater deviation with respect to the original Sheldon-method,
2. higher correlations among the three components,
3. fewer relations with motor ability (especially strength and speed test).

All these findings lead us to the conclusion that the proposed method is a fairly good technique to estimate the somatotype.

REFERENCES

Damon, A.—Bleibtreu, H. K.—Elliott, O.—Giles, E. (1962): Predicting somatotype from body measurements. — Am. J. Phys. Anthr., *20;* 461—473.

Dupertuis, C. W.—Tanner, J. M. (1950): The pose of the subject for photogrammetric anthropometry, with special reference to somatotyping. — Am. J. Phys. Anthr., *8;* 27—47.

Cureton, T. K. (1947): *Physical Fitness Appraisal and Guidance.* — St. Louis, Mosby, p. 120.

Heath, B. H. (1963): Need for modifications of somatotype methodology. — Am. J. Phys. Anthr., *21;* 227—233.

Heath, B. H.—Carter, J. E. L. (1966): A comparison of somatotype methods. — Am. J. Phys. Anthr., *24;* 87—99.

— — (1967): A modified somatotype method. — Am. J. Phys. Anthr., *27;* 57—74.

Munroe, R. A.—Clarke, J. J.—Heath, B. H. (1969): A somatotype method for young boys. — Am. J. Phys. Anthr., *30;* 195—201.

Parnell, R. W. (1954): Somatotyping by physical anthropometry. — Am. J. Phys. Anthr., *12;* 209—239.

— (1957): Physique and mental breakdown in young adults. — Brit. Med. J., *1;* 1485—1490.

— (1958): *Behaviour and Physique. An Introduction to Practical and Applied Somatometry.* — London, E. Arnold.

Sheldon, W. H.—Dupertius, C. W.—McDermott, E. (1954): *Atlas of Men. A Guide for Somatotyping the Adult Male at All Ages.* — Harper and Brothers, New York.

Sheldon, W. H.—Stevens, S. S.—Tucker, W. B. (1970[3]—1940[1]): *The Varieties of Human Physique. An Introduction to Constitutional Psychology.* — Hafner Publishing Company, Darien, Conn.

Simons, J.—Swalus, P.—Willems, E. J.—Van Gerven, D.—Renson, R.—Beunen, G. (1971): *Studie over de Physical Fitness bij Schoolgaande Jongens van 12- tot 19-jarige leeftijd. Volume I, II.* Dept. Physical Education, K. U. Leuven, Leuven.

Simons, J.—Beunen, G.—Renson, R. (1974): *The Louvain Boys' Growth Study. Preliminary report.* Dept. Physical Education, K. U. Leuven, Leuven.

Swalus, P. (1966): Comparaison de différentes techniques de somatotypie basées sur la méthode de Sheldon. — *Trav. Soc. Méd. Belge Educ. Phys. Sp., 19;* 65—75.

Swalus, P.—Beunen, G.—Ostyn, M.—Renson, R.—Simons, J.—Van Gerven, D.—Willems, F. (1970): Comparaison des méthodes de Sheldon, Parnell et Heath-Carter pour la détermination du somatotype ou du phénotype. — *Kinanthropologie, 2;* 31—42.

Willgoose, C. E. (1961): *Evaluation in Health, Education and Physical Education.* New York, McGraw-Hill, p. 303. — *Cit. in:* Clarke, H. H. (1967[4]). *Application of measurement to health and physical education.* New Jersey, Prentice Hall, p. 108.

Authors' addresses: Dr. Albrecht Claessens
Dr. Gaston Beunen
Prof. Dr. J. Simons
Prof. Dr. Michel Ostyn
Dr. R. Renson
Dr. D. van Gerven
Instituut Lichamelijke Opleiding Katholieke Universiteit Leuven
Tervuursevest 101
B 3030 Heverlee
Belgium

Prof. Dr. P. Swalus
Institut d'Education Physique Université Catholique de Louvain
Place P. de Coubertin 1.
B 1348 Louvain-la-Neuve
Belgium

Anthrop. Közl. *24;* 55–62. 1980.

CLUSTER ANALYSIS IN ANTHROPOLOGY

by R. Corluy

(Center for Biomathematics, Free University Brussels, Belgium)

A b s t r a c t. Although a large variety of cluster analysis methods is available, only those based on the concept of "natural" cluster may be used in anthropology, since we have no prior knowledge of the structure of the OTU's in a multidimensional space. A method for comparing cluster techniques in an objective way will be discussed by identifying clustering results with matrices and establishing a distance between these matrices. Differences between "hard clustering" and "fuzzy clustering" will also be pointed out, and, as a useful compromise, we introduce an altered version of neighbourhood limited classification. Thanks to the concept of "neighbourhood of a point", regions of space of varying density are found to be independent of their cluster shape. As a consequence of the overlapping of neighbourhoods, points already in a cluster may have relationships with points in other clusters. If clusters stand for populations, the method provides us with a technique for introducing overlapping populations and for a quantification of the properties in which populations differ.

Key words: hard cluster analysis, fuzzy cluster analysis, neighbourhood limited classification.

Introduction

The last two decades have shown an intense use of computer-techniques in every scientific field where a large amount of numerical data is handled. The methods of multivariate analysis turned out to be very useful in the life sciences, and especially in anthropology. This paper deals with the popular technique of cluster analysis (CA) and its purpose is to give the non-mathematical user some insight into the problems with which he can be faced, and also into our arguments in favour of the neighbourhood limited classification (NLC) method which, in our view, is of particular interest for anthropologists.

The need of distances or metrics

A fundamental question in anthropology is: in what measure two objects (individuals, fossils, ...) differ? Literature shows that the question can be answered by introducing indices of similarity or indices of dissimilarity on the one hand and distances on the other hand. A distance or metric between the elements a_i of a set A is defined as a function d: $A \times A \rightarrow R^+$ such that:

$$\forall i, j, i \neq j: \ d(a_i, a_j) > 0$$

$$i = j: \ d(a_i, a_j) = 0$$

$$\forall i, j: d(a_i, a_j) = d(a_j, a_i) \qquad \text{(symmetry)}$$

$$\forall i, j, k: d(a_i, a_j) + d(a_j, a_k) \geq d(a_i, a_k) \qquad \text{(triangular inequality)}$$

There are two important properties of distances which indices fail to possess. The triangular inequality corresponds to the intuitive notion that if a_i resembles (is near to) a_j, and a_j resembles a_k, then a_i and a_k will resemble one another, too. Secondly, distances are additive: in fact any linear combination of distances remains a distance. So one can add, for instance, distances based on anthropometric data between two individuals to distances based on blood groups (even weighted with coefficients) between the same individuals to obtain a generalized distance. Although it is not the case in anthropology, the symmetry property may be annoying: if one wants in psychology to measure the affection between two persons, and if a_i is in a certain affective relation with a_j, it is possible that this relation is not reciprocal. Suppose now that two objects a_i and a_j are measured for s variables and that x_{ik} represents the value of the *kth* variable for object a_i. The Minkowski distance is given by:

$$d(a_i, a_j) = \left(\sum_{k=1}^{s} (x_{ik} - x_{jk})^p \right)^{1/p}$$

In anthropology, one quite often uses the special cases:

$$p = 2 \quad d(a_i, a_j) = \sqrt{\sum_{k=1}^{s} (x_{ik} - x_{jk})^2} \quad \text{called Euclidian metric.}$$

$$p = 1 \quad d(a_i, a_j) = \sum_{k=1}^{s} | x_{ik} - x_{jk} | \quad \text{called Manhattan metric.}$$

The Manhattan distance is particularly well suited for binary variables, whereas the Euclidian is generally used for quantitative variables. However, SNEATH and SOKAL (1973) argue for the Manhattan distance when the scale units of the variables are of equal value. Indeed, consider two individuals a and b, measured each for two bone lengths: a(10 cm, 20 cm); b (20 cm, 40 cm).

Euclidian distance: $d(a, b) = \sqrt{(10-20)^2 + (20-40)^2} \sim 22.36$

Manhattan distance: $d(a, b) = | 10-20 | + | 20-40 | = 30$

Figure 1 clearly shows that the Manhattan distance conserves the differences for each variable in its structure.

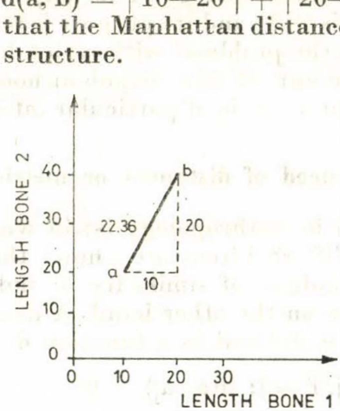


Fig. 1: **Comparison of Euclidian and Manhattan distances**

Problems of cluster analysis

Suppose now one has found a table of distances between n objects: this table is a symmetrical matrix with n(n-1)|2 non-zero distances, and n distances equal to zero, situated on the main diagonal. A problem in anthropology however, is not only asking if individual a_i is nearer to individual a_j than to individual a_k, but also examining if there are groups of individuals which are nearer one another than other groups in the population. In other words one has a classification problem. CA stands for a variety of classification techniques, where the word classification has to be understood as a partition of a given set of objects in groups or clusters. Given a problem, one generally agrees on the nature of the objects one wants to classify and which are called OTU's (operational taxonomic unit). At the initial stade one may not forget that most CA techniques are merely descriptive, and that intersections between clusters are empty. In biology, distinction between species is vague and using an arbitrary CA method for obtaining a classification in species starting from a given sample of individuals is useless since the existence of hybrids.

Most of the CA methods suffer from an important disadvantage. Each OTU can be represented as a point in a space of s dimensions, each point having s co-ordinates, namely the values of the s variables. But one has no idea of the forms of the eventual clouds of points in this s dimensional space. Generally most methods start by fusing the two OTU's which have the smallest distance. Then methods begin to differ by answering the question: "what is the distance between a point and a cluster?", and in a more advanced state, "what is the distance between two clusters?" Most answers are based on the assumption that clusters are spherical and compact. Therefore, these methods are unable to discover, for instance, the two clusters of Fig. 2.

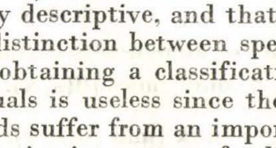


Fig. 2: Example of two non-spherical clusters

Neighbourhood limited classification (NLC)

Natural cluster and neighbourhood

The concept of natural cluster has been introduced to get rid of the spherical form of a cloud. A human observer can easily examine with his eyes the repartition of flowers in a meadow. He sees regions of a varying density of flowers and he arranges the flowers in groups according to their density, independently of the forms. The computer imitiation of this procedure is called natural clustering. Therefore, one ought to define the neighbourhood of a point. In Fig. 3, the intersections of neighbourhoods of points are non-empty, and the chaining of non-empty neighbourhoods gives in fact the clusters, whatever their forms may be.

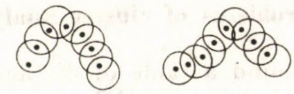


Fig. 3: **Chaining of neighbourhoods, giving two clusters**

Suppose now one has a set S of OTU's and the Euclidian distances having been calculated and arranged in a distance matrix. For each OTU $s \in S$ one defines its neighbourhood N(s), such that the relation is symmetric:

$$s \in N(t) \Leftrightarrow t \in N(s) \text{ with } t \in S.$$

We kept three definitions:

$$t \in N(s) \Leftrightarrow d(s, t) \leq \overline{d(x, y)}_{\substack{x, y \in S \\ x \neq y}} \quad (1)$$

where $\overline{d(x, y)}$ is the mean distance of all non-zero distances between two objects.

$$t \in N(s) \Leftrightarrow d(s, t) \leq \max_{x \in S} \{\max [d(s, x), d(x, t)]\}_{s \neq t} \quad (2)$$

$$t \in N(s) \Leftrightarrow d(s, t) \leq \max_{x \in S} \{\min [d(s, x), d(x, t)]\}_{s \neq t} \quad (3)$$

With Def. (1) we consider a sphere with each point as center, having as radius the mean distance between all pairs of points. Neighbours of s are then all points situated in the interior or on the sphere. This definition turned out to be too strong, giving neighbourhoods which were too extended, although non-spherical clusters were discovered. When we consider two spheres with centers, s and t and having the same radius d(s, t), then def. (3) says that $t \in N(s)$, if we can find at least one element $x \in S$ which lies outside or on the union of the two spheres: two points are neighbours if they are lying both far enough from other points. This definition is a somewhat altered version of that of Oxnard and Neely (1969). Definition (2) means that $t \in N(s)$ if we can find at least one point $y \in S$ which lies outside or on the intersection. We have:

$$N(s)_{(3)} \subset N(s)_{(2)}$$

Most users prefer def. (3) since the points x are then situated far from s and t, whereas with def. (2) it may happen that this is only the case for s or t. The definitions remain valid if one uses the Manhattan metric: in R^2 the circles become squares and using (3): $t \in N(s)$ if there lies at least one point $r \in S$ outside or on the union of the squares (Figs 4 and 5).

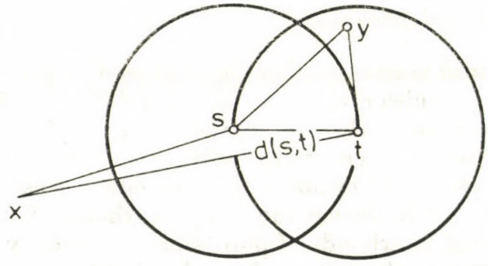


Fig. 4: **s and t are neighbours, since x lies outside the union (3), or y outside the intersection (2)**

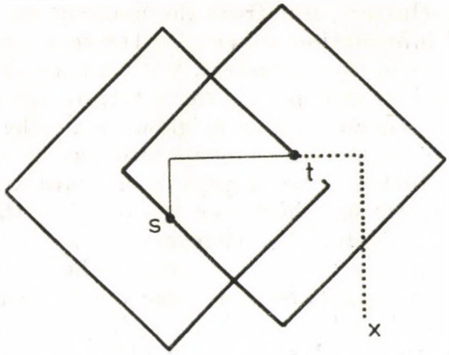


Fig. 5: s and t are neighbours, since x lies outside the union of the squares

Density, association, interface and the NLC procedure

As a measure for the density around each point, one takes the inverse of the mean distance between s and all the elements of N(s):

$$w(s) = \frac{1}{\bar{d}_s} \text{ with } \bar{d}_s = \frac{1}{n_s} \sum_{i \in N(s)} d(s, i), \; n_s = \# \left(N(s)\right)$$

If $t \in N(s)$, one has:

$$w(s) = \frac{n_s}{\sum\limits_{i \in N(s)} d(s, i)} \leq \frac{n_s}{d(s, t)}; \quad w(t) = \frac{n_t}{\sum\limits_{j \in N(t)} d(t, j)} \leq \frac{n_t}{d(s, t)}$$

The association between two neighbouring points is defined as:

$$a(s, t) = \frac{w(s) \cdot w(t)}{d(s, t)} = \frac{1}{d(s, t)\, \bar{d}_s \bar{d}_t} \leq \frac{n_s n_t}{d^3(s, t)}.$$

The initial matrix of distances is replaced by an association values table. Instead of running through the whole distance matrix, during the cycles of the program, the computer only considers the association values, the number of which is inferior to that of the distances. In the agglomerative procedure the elements with the highest association are fused. The association values are then recalculated, and the same procedure starts again. This is only possible if one defines the association between clusters. Suppose one has two clusters U and V and $v \in N(u)$ with $u \in U$ and $v \in V$. The set of the couples (u, v) is called the interface I(U, V) of U and V, as introduced by Oxnard and Neely (1969). The association between U and V is calculated as:

$$a(U, V) = \overline{\underset{(u, v) \in I(U, V)}{a(u, v)}}$$

In other words, one takes the mean value of all the associations of all couples belonging to the interface of U and V. The concept of interface is the second at least as important advantage of the method: one may choose an optimal clustering in this agglomerative procedure. Indeed, most methods give a partition of the elements in clusters, but from the moment an element belongs to a cluster, one looses all information concerning the relations of that particular element with the elements in other clusters. With this method on the contrary, each cluster is composed of two parts: the interior and the boundary. The interior is the set of all elements whose neighbours also belong to the cluster, whereas the boundary is the set of elements also having neighbours in other clusters. The interior (which can be empty) is the hard kernel of the cluster, composed of those elements of which one is sure that they are not related with elements outside the cluster. The elements of the boundary, on the contrary, do have associations with elements outside the cluster, although these associations are inferior to the ones inside the cluster. Investigations of the number of elements in the interior and the boundary can be relevant for judging the homogeneity within a cluster. As in other CA methods, the output consists of a dendogram in function of the associations but gives also, at every cycle, the interfaces. Depending on his particular problem, the user has to choose the optimal clustering in function of the associations and of the elements in interiors and boundaries. One may be particularly interested in the variables responsible for elements in the boundaries. The program (CORLUY, in press) is written for extracting these elements, and calculates the correlation matrix between the variables, so that a factor analysis can be carried out. Figure 6 shows two clusters A and B, with elements in interiors and boundaries.

OXNARD and NEELY (1969) give an interesting anthropological example: NLC clustering of samples of Homo Sapiens, Pan, Pongo and Gorilla based on eight morphological variables measuring primate shoulders. Although misclassifications occur (due to the morphological variation within a species), one need not be annoyed since these misclassifications are revealed by the inspection of the interfaces.

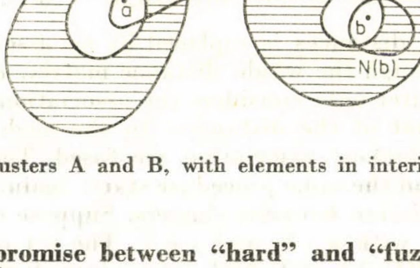


Fig. 6: **Two clusters A and B, with elements in interiors and boundaries**

NLC: compromise between "hard" and "fuzzy" clustering

In hard CA the aim is to find r non-empty sub-sets of S with $2 \leq r < n$ (number of OTU's). Such a clustering can be completely characterized by a real matrix U_{cxn} with c rows and n columns, so that its elements u_{ik} satisfy:

$$u_{ik} \in \{0, 1\} \quad 1 \leq i \leq r; \; 1 \leq k \leq n \tag{1}$$

$$\sum_{i=1}^{r} u_{ik} = 1 \quad 1 \leq k \leq n \tag{2}$$

$$\sum_{k=1} u_{ik} > 0 \quad 1 \leq i \leq r \tag{3}$$

Indeed, (3) means that no cluster is empty since the sum of the elements of each row is strictly positive; (1) and (2) say that each OTU belongs to a cluster, and that the intersections are empty (the sum of the elements of each column adds up to one). In anthropology, however, S is generally composed of individuals of which the characters overlap: S may represent a sample of two or more sub-populations. In fuzzy clustering one avoids the "absent or present" state in a cluster by replacing (1) by

$$u_{ik} \in [0, 1] \quad 1 \leq i \leq r; 1 \leq k \leq n \tag{4}$$

Conditions (2) and (3) remain unchanged. Fuzzy clusters give an individual the possibility of having a partial belongingness to different clusters. The u_{ik} are called degress of belongingness. The sum of the degress of belongingness is equal to one for each OTU. No fuzzy cluster is empty either. The new condition (4) softens the frontiers between fuzzy clusters. Methods for fuzzy clustering are still in full development (see RUSPINI 1973), and not used to a great extent in our field of interest as yet. One may, however, consider the NLC as an interesting compromise between hard and fuzzy clustering by attributing the degress $(0, \ldots, 1, \ldots, 0)$ to the elements of the interiors of the clusters (one and r-1 zeros) whereas the elements of the boundaries would have degrees of belongingness $(\alpha_1, \ldots, \alpha_r)$
with

$$\sum_{i=1}^{r} \alpha_i = 1 .$$

The degress of belongingness of the element s_i $(i = 1, \ldots, n)$ are, if one denotes by

$$\theta_j = \overline{a(s_i, t)}, \; t \in N(s_i) \cap J, \; j = 1, \ldots, r$$

given by

$$\alpha_j = \theta_j / \sum_{k=1}^{r} \theta_k$$

(J represents the *jth* cluster)

Of course, other solutions for the α_j are possible, depending on the particular problem of the investigators.

Summary

Properties and advantages of the use of distances instead of indices of dissimilarity are shown. To overcome the assumption of spherical clusters, one discusses also the advantages of concepts such as neighbourhood of an OTU, density, association between OTU's, interior and boundary of a cluster, interface between clusters.

REFERENCES

BEZDEK, J. C. (1974): Mathematical Models for Systematics and Taxonomy. — *In: Proceedings of the Eighth International Conference of Numerical Taxonomy.* Freeman and Company, San Francisco.

Corluy, R. (1977): *Factor and Cluster Analysis.* — Publications of the Vrije Universiteit Brussel, Dienst Uitgaven. Brussels.
— (in press): A modified version of neighbourhood limited classification for the life sciences. — HWPR, Humane Wetenschappen Programmeringseenheid, Vrije Universiteit Brussel. Brussels.
Estabrook, G. F.—Rogers, D. J.—Wirth, M. (1966): A graph theory model for systematic biology, with an example for the Oncidiinae. — Syst. Zool. *15;* 59—69.
Jardine, N.—Sibson, R. (1971): *Mathematical Taxonomy.* J. Wiley & Sons Ltd., London.
Oxnard, C. E.—Neely, P. (1969): The descriptive use of Neighbourhood Limited Classification in functional morphology: An analysis of the shoulder of Primates. — J. Morphol. 2, *129;* 127—148.
Ruspini, E. H. (1970): Numerical methods for Fuzzy Clustering. — Information Sciences, *2;* 319—350.
— (1973): New experimental results in Fuzzy Clustering. — Information Sciences *6;* 273—284.
Sneath, P.—Sokal, R. (1973): *Numerical Taxonomy.* — Freeman and Company, San Francisco.

Author's address: Prof. Roland Corluy
Center for Biomathematics, Vrije Universiteit Brussel
Pleinlaan 2
B 1050 Brussels
Belgium

Anthrop. Közl. *24;* 63–68. 1980.

ALLOMETRIC VERSUS MULTIVARIATE APPROACHES TO PROPORTIONALITY ASSESSMENT USING REFERENCE POPULATIONS

by D. T. DRINKWATER and M. A. VAN'T HOF

(Kinesiology Department, Simon Fraser University, Burnaby, B. C., Canada; Department of Statistical Consultation, University of Nijmegen, Nijmegen, The Netherlands)

Abstract. The assessment of proportionality may be done *directly* using an allometric approach where changes in body dimensions may be expressed as height to some power, or *less directly* using multivariate methods where, under most circumstances, body dimensions may be expressed as linear functions of height. The allometric approach of Ross and WILSON (1974) attempts to simplify proportionality assessment, however their assumption of geometrical similarity is not valid if one wishes to separate the normally expected proportionality changes which occur with increasing height from the effects of other influences. Using multivariate methods, control for these changes with height may be achieved by standardizing data to a real known reference rather than a hypothetical one. Furthermore, the multivariate approach allows for control of the confounding effects of other variables in addition to height. Thus the use of a multivariate approach and a real population reference may be preferable to the Ross–Wilson 'Phantom' stratagem for proportionality assessment.
Key words: allometry, multivariate analysis, proportionality.

Introduction

A frequent endeavour of human biologists is the comparison of the morphological characteristics of individuals or groups. Recently the assessment of height related proportionality characteristics of children and athletes has been of interest to investigators (EIBEN et al. 1976, EIBEN 1978, Ross et al. 1977, Ross et al. 1979). What is of concern is how such groups differ from one another and from a 'normal' population.

In 1974 Ross and WILSON proposed a method for the proportionality assessment of body dimensions. They used a hypothetical unisex reference or 'Phantom' as a universal standard, or 'normal' population, and presented a procedure for the transformation of morphological data to 'Phantom' standardized proportionality values. Their intent in standardizing all data geometrically adjusted to a height of 170.18 cm was to examine differences in proportionality as compared to an average male–female adult, and facilitate the comparison of proportionality among individuals or groups.

Provided one is interested *only* in describing and evaluating absolute proportionality for various groups, then the Ross–Wilson approach is a convenient means of doing this. If, however, one wishes to determine to what extent observed proportionality differences might be attributable to normally expected changes which occur with increasing height, then the Ross–Wilson geometric scaling approach is inappropriate.

Allometry and proportionality

If body dimensions increased geometrically with height then proportionality should remain constant with increasing height. But the proportionality value for any variable does not necessarily remain constant but rather may change with increasing height. This is illustrated in Fig. 1b for the data shown in Fig. 1a. This suggests that body dimensions do not increase geometrically with height.

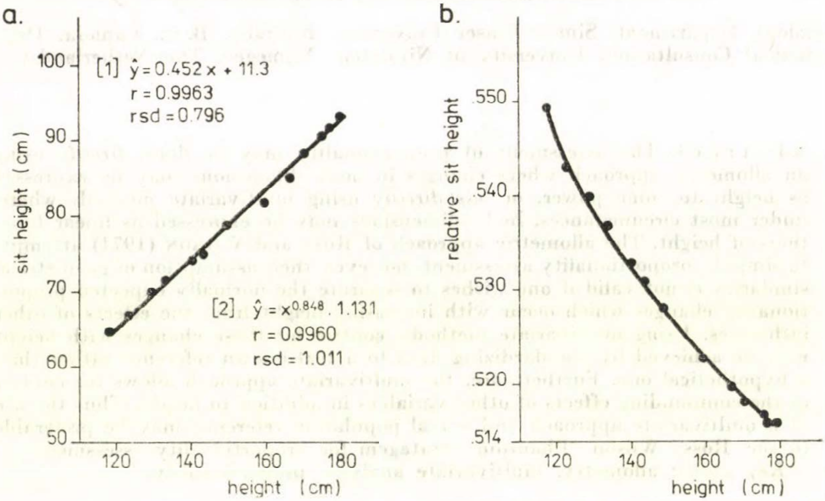


Fig. 1a: Mean sit heights for boys 6—18 years from COGRO, Ross et al. 1979
Fig. 1b: Smoothed relative sit heights for boys 9—18 years calculated from est. sit heights using Eq. (1), Fig. 1a

The rate of change of one variable with respect to another, or the dimensional relationship of any variable with another such as height, may be best expressed by the allometric equation as discussed by MARSHALL et al. (1979). Thus the rate of change of sit height with respect to height can be expressed as height to some power. If sit height were to increase geometrically relative to height such that the proportionality value remained constant, then the exponent should be 1. That the exponent is less than 1, specifically 0.848 as shown by Eq. (2), Figure 1a, indicates that the rate of increase in sit height is less than the rate of increase in height in this particular population.

Since the Ross—Wilson approach does recognize this dimensional aspect and provision is made in their z-value formula for the adjustment of the dimensional exponent to the appropriate population specific value, it is possible to correct for the confounding effect of height on proportionality in this manner. An extention of the 'Phantom' should, therefore, include the dimensional relationships of all variables with height as exist in a 'normal' population.

Referring to Table 1, if one uses the strictly geometrical relationship in the Ross—Wilson formula, significant differences in proportionality can be shown to exist between the two groups. However, by using the appropriate dimensional exponent, thereby controlling for height related change, it can be shown that the proportionality differences dissappear. In other words, the observed differences are wholely attributable to 'normal' proportionality changes associated with increasing height and not to 'true' differences between the groups as a result of different treatments. Such partitioning out of the 'normal' proportionality changes would be particularly useful in assessing proportionality of various groups such as athletes for instance.

Table 1

Comparison of proportionality differences in sit height for boys using the 'Phantom' stratagem before and after using the appropriate dimensional exponent to control for height related proportionality changes. Data synthesized from COGRO, Ross et al. 1979.

$$z = \frac{1}{s} \cdot \left[v \cdot \left(\frac{170.18}{ht} \right)^d - P \right]$$

where $P = 70.98$, $s = 4.54$, $d =$ dimensional exponent, $v =$ variable of interest, $ht =$ measured height

group age 8 N = 22 ht = 129 cm sit height 70 (3) cm	where $d = 1$ $z = 0.34$ (.87)	where $d = 0.848$ $z = -0.49$ (.84)
group age 18 N = 21 ht = 179 cm sit height = 93 (3) cm	$z = -0.52$ (.63)	$z = -0.37$ (.63)
min t ($p \leq 0.05$), DF = 41 $t = 2.02$	$t = 3.74$ significant	$t = -0.50$ not significant

The use of peer reference groups and the 'Phantom' stratagem

In the absence of specific population information regarding the proportionality changes with height, one might make comparisons with an appropriately matched peer or 'norm' group. Such an approach was demonstrated by Ross et al. (1979) using an age matched peer group to assess proportionality in 11 years old female figure skaters. While the use of an age matched peer group whether there were proportionality differences between groups of a given age, a better assessment of the differences might have been made using a height matched as well as age matched peer group. But this example does illustrate an awareness that in growing children proportionality changes are age as well as height dependent.

Thus the Ross—Wilson 'Phantom' as a hypothetical and highly generalized description of average adult size can serve only as a useful reference for depicting a 'standardized' proportionality value — nothing more since the assumption of geometrical similarity is inappropriate for the control of height when one wishes to separate proportional differences observed as to expected height related changes and to the effects of other influences.

A multivariate approach and the use of real reference populations

An alternative approach for the evaluation of proportionality is to use multivariate techniques and look at the magnitudes of the variables of interest for each group after statistically controlling for height. Although one does not look at proportionality values directly using such techniques, one can infer whether one group is proportionally larger than the 'normal' population at a given height if the group value is greater than the estimated population value at that height. In this way one can compare groups controlling for the effect of height by determining how much each group differs from the population at their respective heights and hence from one another. Furthermore, whereas only the effect of height can be controlled in the Ross—Wilson approach by using the appropriate dimensional exponent for each variable, the multivariate approach allows for the control of other variables in addition to height. Thus, for example, one could look at the relative magnitude of arm girth in two groups of athletes after controlling for the effect of height and the size skinfold. Such partitioning out of the confounding effects of skinfold size could further aid in explaining differences between groups. The multivariate approach is our method of choice since many morphological relationships can be reasonably approximated over the range we are interested in by linear regressions such as shown in Eq. (1), Fig. 1a.

Because we are concerned principally with determining whether differences exist between our study groups and a 'normal' sex specific population we chose to standardize our data to a real rather than a hypothetical reference. Four our reference we require, ideally, a population with a large number of subjects (N greater than 1000) covering the height range in which we are interested and for which the variable we commonly use have been measured and the necessary statistics — means, standard deviations, and correlation matrix — have been reported. The large number of subjects ensures that the errors in the calculated coefficients, used in the regression equations developed via this multivariate approach to describe our 'normal' population, are negligibly small. The subsequent scores, standardized to our reference, that are derived by this approach, therefore, have negligible error associated with them.

That this approach can yield the same information as the modified Ross—Wilson method (Table 1) is shown in Table 2. Using synthesized values for a reference population of boys and disregarding age related changes, the data are transformed to scores standardized to this reference before and after statistically controlling for height.

Since it can be demonstrated that given a fairly high relationship between height and any variable, that the quotient or proportionality value calculated from the estimated value of a variable at a given height divided by that height is a good approximation of the mean the proportionality value for that height, should we wish to look at proportionality characteristics as such, it is possible to convert the transformed data obtained via our multivariate approach to Ross—Wilson z-values. While this is a somewhat indirect way of

Table 2

Comparison of sit height of boys using multivariate techniques and a reference population to control for height related changes. Data synthesized from COGRO, Ross et al. 1979.

regression of sit height(y) on height(x) — $\hat{y} = 0.452 \cdot x + 11.3$, $r = 0.996$, $rsd = 0.796$

	direct comparison	multivariate comparison
group age 8 N = 22 ht = 129 cm sit height = 70 (3) cm		z = 0.50 (3.77)
group age 18 N = 21 ht = 179 cm sit height = 93 (3) cm		z = 1.00 (3.77)
min t ($p \leq 0.05$), DF = 41 t = 2.02	t = −21.74 significant	*t = −0.43 not significant

* Note — By inference, proportional sit height of the 8 year-old boys is *not* significantly smaller than the 18 year-old boys after controlling for height.

assessing proportionality differences in the absence of the dimensional relationships being given for the reference population, it is doubtful that any more information would be gained from doing this.

What our approach allows, then, like the Ross—Wilson approach is the convenience of standardization of data to a common reference such that differences between groups becomes readily apparent. But unlike the Ross—Wilson method, our real population reference contains the information necessary to allow us to partition out height related changes in any variable and the effects of any other confounding variable to look at the 'true' differences between groups if we wish so. Since we are not looking directly at proportionality relationships in the manner of Ross and Wilson, it is not necessary to know the dimensional relationships with height for all variables in our population.

Conclusion

Like Ross and Wilson, we do propose that the use of standard population references could indeed be rewarding in the evaluation of morphological data. What is needed are adequate male and female reference groups, and perhaps even a unisex reference. Much would depend on the questions being asked. But for the assessment of proportionality, we suggest that a multivariate approach using a peer group of some sort might be more expedient than applying the Ross—Wilson approach in the absence of dimensional information for the 'Phantom', or the use of a series of height matched groups processed via the 'Phantom' stratagem.

REFERENCES

EIBEN, O. G. (1978): Changes in body measurements and proportion of children, based on Körmend Growth Study. — *In:* GEDDA, L.—PARISI, P. (Eds): *Auxology: Human Growth in Health and Disorder*, pp. 187—198. — Academic Press, London, New York, San Francisco.

EIBEN, O. G.—ROSS W. D.—CHRISTENSEN, W.—FAULKNER, R. A. (1976): Proportionality characteristics of female atheletes. — Anthrop. Közl. *20;* 55—67.

MARSHALL, G. R.—BAILEY, D. A.—LEAHY, R. M.—ROSS, W. D.—VAJDA, A. S. (1979): Allometric growth in boys studied longitudinally age seven to sexteen years. — *In:* NELSON, R. C.—MOREHOUSE, C. A. (Eds): *Kinanthropometry* I., — University Park Press, Baltimore, Md.

ROSS, W. D.—BROWN, S. R.—FAULKNER, R. A.—VAJDA, A. S.—SAVAGE, M. V. (1977): Monitoring growth in young skaters. — Can. J. Appl. Sport Sciences, *1;* 163—167.

ROSS, W. D.—DRINKWATER, D. T.—WHITTINGHAM, N.—FAULKNER, R. A. (1979): Anthropometric prototypes age six to eighteen years. — *In:* BERG, K.—ERIKSSON, B. O. (Eds): *Children and Exercise IX*. Pediatric Work Physiology IX, Marstrand, Sweden, — University Park Press, Baltimore, Md.

ROSS, W. D.—WILSON, N. C. (1974): A stratagem for proportional growth assessment. — *In:* BORMS, J.—HEBBELINCK, M. (Eds): *Children and Exercise.* VIth Internat. Symposium on Pediatric Work Physiology, den Haag, 1973. — Acta Pediatrica Belgica, Suppl. 169—182.

Authors' addresses: Dr. DONALD T. DRINKWATER
Dept. Kinesiology, Simon Fraser University
Burnaby 2. B. C. V5 A 1S6
Canada

Prof. MARTIN A. VAN'T HOF
Dept. Statistical Consultation, University of Nijmegen
Nijmegen
The Netherlands

Anthrop. Közl. 24; 69—76. 1980.

PROBLEMS OF METRIC IN BIOTYPOLOGY

by O. G. EIBEN—K. CSÉBFALVI

(Department of Anthropology, Eötvös Loránd University, Budapest, Hungary; Education Centre, Ministry of Heavy Industry, Esztergom, Hungary)

A b s t r a c t. When analysing variations of physique, the authors often came up against difficulties brought on by the lack of a metric defined especially for the human physique and/or by the uncleared state of the questions connected with such a metric.

Let H = (a, b, c, . . .), a set of examined human physiques, of which the elements are body measurement vectors belonging to each physique. Obviously, the distance $\varrho(x, y)$ $(x, y \in H)$ between the physiques may be defined in many ways so that the relationships

$$\varrho(x, y) = 0 \Leftrightarrow x = y$$
$$\varrho(x, y) > 0 \Rightarrow x \neq y$$
$$\varrho(x, y) = \varrho(y, x)$$
$$\varrho(x, y) \leq \varrho(x, z) + \varrho(z, y)$$

should be valid.

In earlier times as a rule the conscious or — for reasons of computation — implied use of the Euclidean metrics (Pythagorean distances) was universal in the practice of anthropometry. The multivariate statistical methods — in the first place discriminance analysis and cluster analysis — clearly showed that the issue of applying a suitable metrics in anthropometric practice was practice was by far not free from problems.

In the authors' opinion a well- (exactly and expediently) defined metric is in itself a useful tool of the practice of anthropometry. They succeeded in tracing back the problems come up to solutions of exercises, in which solutions econometrics is more ahead. In their paper they present a suitable kind of metric.

Key words: metric, factor analysis, physique, biotypology.

Introduction

Owing to the possibilities presented by modern computation techniques the use of multivariate methods based on processing great quantities of data has rapidly gained currency in the past decade in various domains of anthropometry. Numerous results with a wide range of applications have been attained by using generalized component analysis (e.g. EIBEN 1969, 1972), factor analysis (e.g. EIBEN—CSÉBFALVI 1977), cluster and discriminance analysis. A great number of relationships have come to light which had remained hidden from direct intuition before.

However, as so often in the history of science, in this field too, the phenomenon can be observed that when a sudden extensive sweep of a group of methods has taken place then, after a while, one must go back to the very foundations. Some basic questions have namely to be clarified, which though for a long time tacitly assumed to be clear, in the interest of further advance have to be settled much more precisely, so to say on the level of axioms.

There are numerous signs in the literature which indicate that at points independent of one another, but at the same time not accidentally, some problems arise which can be traced back to just such questions needing to be cleared up.

One of the topics of this kind to be cleared on the level of the fundations is the problem of the so-called *metric*.

In the application of the most multivariate methods no problem was caused e.g. by the fact that implicitly we made use of a metric of Pythagorean type which determined the distance between two physiques represented, say, by body measurement vectors x and y by the formula (*).

$$x = \begin{bmatrix} x_1 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ x_n \end{bmatrix}; \qquad y = \begin{bmatrix} y_1 \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ y_n \end{bmatrix}$$

$$(*) \qquad \varrho(x, y) = \sqrt{\sum_{i=1}^{n} \gamma_i (x_i - y_i)^2},$$

where $\gamma_i \geq 0$, a weighting factor.

This metric is especially advantageous in respect of computation, since in this way relatively simple and clear methods are at our disposal for calculations founded on Gauss's method of least squares. By the way, this metric also has a special role in the examination of universes characterized by variables of normal distribution. Just, therefore, only few troubled about the problem that no direct anthropological meaning could be given to this metric. To demonstrate this on a simple example, let us consider two physiques, characterized by two body measurements (x_1, y_1 stature, x_2, y_2 body weight):

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 172 \text{ cm} \\ 64 \text{ kg} \end{bmatrix}; \quad y = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} 183 \text{ cm} \\ 89 \text{ kg} \end{bmatrix}$$

Matching with each of these points on the two-dimensional plane, we obtain Fig. 1 as follows:

The anthropological meaning of the distance

$$\varrho = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

is not directly clear and, apart from formal advantages, it is actually not justifiable either.

The questions connected with metric can be discussed on two different levels.

(i) On one of these, the *mathematical* level, the problem can be regarded as completely clarified. The mathematical definition of metric, in fact, complies

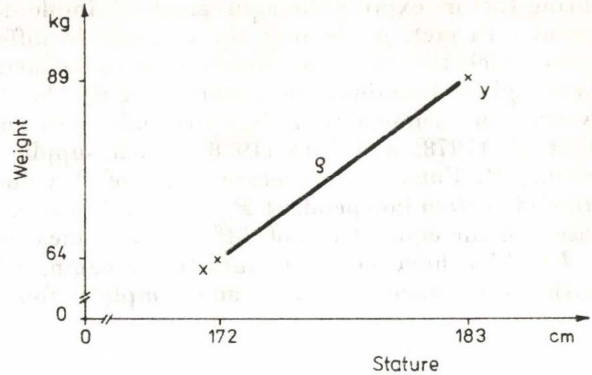


Fig. 1: Two physiques, characterized by two body measurements (x_1, y_1 stature; x_2, y_2 body weight) matched on a two-dimensional plane (see text)

with the requirements of intuition. Let us, namely, denote the "distance" of the x and y measurement vectors with $\varrho(x, y)$. Then one has to determine this in a way such that

(1) $\varrho(x, y) \geq 0$ (positivity)

(2) $\varrho(x, y) = 0 \Leftrightarrow x = y$

(3) $\varrho(x, y) = \varrho(y, x)$ (symmetry)

(4) $\varrho(x, y) \leq \varrho(x, z) + \varrho(z, y)$ (triangle inequality).

(ii) Complying with the above definition there are innumerable ways of introducing a metric. The Pythagorean distance mentioned above is but one of the possible ones. It is a harder task to select the one answering the biotypological respects from among these many possible metrics, i.e. to elucidate the question of metric on the level of *anthropology*.

In the present paper the authors should like to report in brief on some results, which may actuate further research in this field.

Findings and Discussion

The authors first started their investigations with a metric of the type (**):

(**) $$\varrho(x, y) = \sum_{i=1}^{n} P_i \mid x_i - y_i \mid$$

expressly oriented to biotypological purposes.

This metric — which of course complies with the mathematical requirements raised here as does the Pythagorean distance—has the advantage that it is based on a notion of equivalence of the discrepancies of body measurements with respect to a given function which is accessible to direct intuition. Here namely the quotients

$$p_{ij} = \frac{P_i}{P_j}$$

of the P_i weighting factors express the equivalent of simple differences in the body measurements. In fact, p_{ij} denotes the measure of difference in the j^{th} measurements, to which the difference in the i^{th} measurements is equivalent with respect to the given function. Since metrics of this kind, using weights, are extensively used in econometry, it is worth calling attention to a result of MIHÁLYFFY et al. (1978) and BOD (1978) which supplies a constructive solution for proving R. FRISCH's conjecture that the P_i values proceed from the determination of certain independent P_{ij} values. (These can be determined more easily, based on the equivalence of differences in measurements, instead of the weights P_i which have no direct intuitive meaning.) This metric can be compared with the Pythagorean one in an example as follows (Fig. 2):

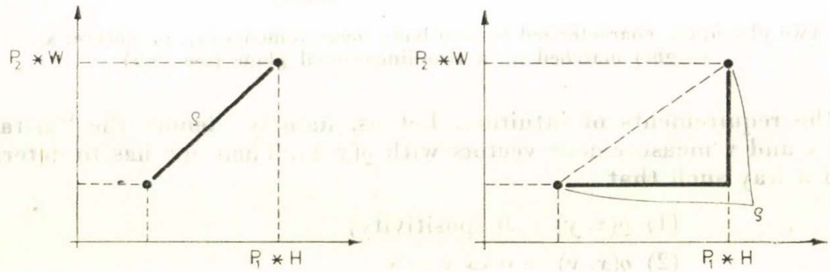


Fig. 2: Comparison of the metric of type (**) with the Pythagorean one (see text)

In the course of the authors' further investigations, the introduction of the metric (***) formula is not too attractive at the first glance, proved rather useful.

(***) $$\varrho(x, y) = \max_i P_i \mid \log x_i - \log y_i \mid$$

The meaning of this is as follows:

$$\mid \log x_i - \log y_i \mid = \left| \log \frac{x_i}{y_i} \right|$$

This expression issues from the comparison of the corresponding pairs of elements taken from the two measurement vectors. The maximum of these gives the distance ϱ of the two measurement vectors. This clearly means that the distance between two physiques is determined by the largest discrepancy with respect to proportion.

Table 1 shows the selected body measurements of two persons, A and B. Beside the values of their body measurements (which in B are always smaller than in A) the authors also give the logarithmic values of them and the difference between these last ones. The greatest differences appear in chest depth and chest circumference.

This metric complies with that instinctive everyday practice that, for a brief characterization of the difference between two physiques one sole body measurement is emphasized, and that is the one showing the highest difference in the proportions of the two physiques. We say, e.g. that A differs in stature "by a head" from B, until — say — their abdomen circumferences show a greater difference than their statures. Then, even among people of different stature, one considers worth mentioning the difference in abdomen circumference. In this way any of the body measurements — relevant as to the examined function — may become decisive as to metric (Fig. 3).

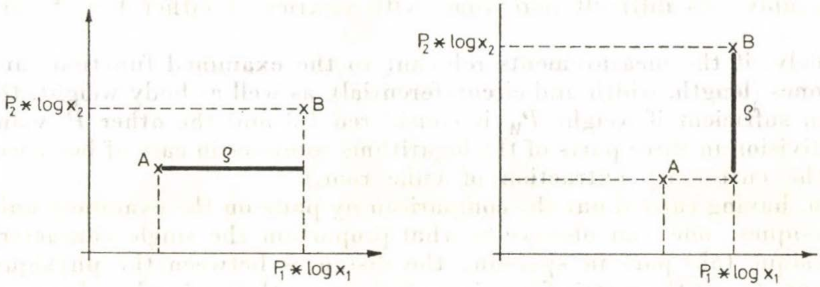


Fig. 3: **In the determination by pairs of the distances of several physiques it will be different characteristics of physique that span the distance of (***) type**

Table 1

Selected body measurements of two persons: A (male) and B (female)

Body measurements	A♂	log♂	B♀	log♀	Δ♂♀
1. Weight	90.0	1.95	55.5	1.75	0.07
2. Stature	178.0	2.25	162.1	2.21	0.04
3. Sitting height	92.0	1.96	84.5	1.92	0.04
4. Span	180.8	2.26	165.5	2.22	0.04
5. Suprasternal height	144.2	2.16	131.3	2.12	0.04
6. Symphysis height	88.7	1.95	81.5	1.91	0.04
7. Acromial height	147.5	2.17	131.5	2.12	0.05
8. Daktylion height	67.9	1.83	60.0	1.78	0.05
9. Spina iliaca ant. sup.	99.5	2.00	91.3	1.96	0.04
10. Biacromial width	43.0	1.63	37.7	1.58	0.05
11. Waist breadth	31.2	1.49	25.6	1.41	0.08
12. Bicristal width	32.5	1.51	28.9	1.46	0.05
13. Bitrochanter width	36.5	1.56.	34.3	1.53	0.03
14. Chest breadth	33.5	1.53	26.3	1.41	0.12
15. Chest depth	23.5	1.38	17.3	1.23	*0.15*
16. Chest circumference	110.0	2.04	78.0	1.89	*0.15*
17. Abdomen circumference	99.8	2.00	81.5	1.91	0.09
18. Trochanter circumference	101.0	2.00	91.5	1.96	0.04
19. Upper arm circumference	31.3	1.50	24.0	1.38	0.12
20. Forearm circumference	28.6	1.46	23.0	1.36	0.10
21. Thight circumference	59.6	1.78	50.0	1.70	0.08
22. Calf circumference	40.7	1.61	32.0	1.50	0.11
23. Bicondylus humeri	7.5	0.88	6.1	0.79	0.09
24. Bicondylus femoris	10.6	1.03	8.9	0.95	0.08

The circumstance that in "spanning" the distance ϱ only *one* body measurement takes part directly at any time, naturally does not mean that, indirectly, the other measurements had no part in forming this distance. It is, namely, these latter measurements which, on account of their lower deviation in proportion, do not exchange roles with the measurement determining the decisive deviation in proportion. It is obvious, further, that in the determination by pairs of the distances of several physiques it will at all times be different characteristics of physique that span the distance of (***) type.

As far as the determination of the weights P_i is concerned, our task may be considerably less difficult here than with metrics of either the (*) or (**) type.

Namely, if the measurements relevant to the examined functions are the usual ones (length, width and circumferential), as well as body weight, then it is often sufficient if weight P_W is considered 1/3 and the other P_i values 1. (This division in three parts of the logarithms complies in case of body weight, with the customary extraction of cube root.)

Then, having carried out the comparison by pairs on the examined universe of physiques, one can observe to what proportion the single characteristics of physique take part in spanning the distances between the physiques. If one wants to use the metric for universal purposes then it is advisable to attain by increasing and/or decreasing the weighting factors, that each of them become a "decisive measurement" in a nearly identical number of cases.

For special examinations of functional biotypology the authors may suggest that just in the formula of type (***) a metric should be chosen in which the values P_i are being left free, and that in a way that — with methods similar to discriminance analysis — this metric should be determined later in an experimental and/or empirical way. A metric of this kind offers, namely, an interesting and useful secondary possibility: besides a quantitative measure it also gives qualitative information. Notably it supplies the very measurement that spans the distance between the two physiques. (Let us consider groups of athletes as e.g. weight lifters or boxers, with whom body weight separates the field automatically. With them the measurement that, founded on the differences in physique, spans the distance is not body weight.) This is the measurement which displays the highest variability. This fact has at the same time also a high biological information value.

Even the first application of the metric of type (***) introduced by the authors brought numerous interesting observations.

One of the first observations of this kind is that — while in the immediate environment of a physique (one of the points of the n-dimensional space), i.e. at fairly low ϱ values, it is practically hardly interesting what metric we use — in the multivariate methods a change-over to the new metric (which is by no means simple mathematically) may lead to substantially different results. Such a consequence of the use of the new metric is especially conspicuous in factor analysis. At the same time, as shown by experience, the results obtained in this way are easy to interpret.

Here and now the authors present the meaning of the metric of type (***) only on a much simpler example.

Let us consider a couple of parents, and let us represent the course of the growth of one of their children "in the system of the parents". One can observe here not only how the distance measured from the two parents changes in

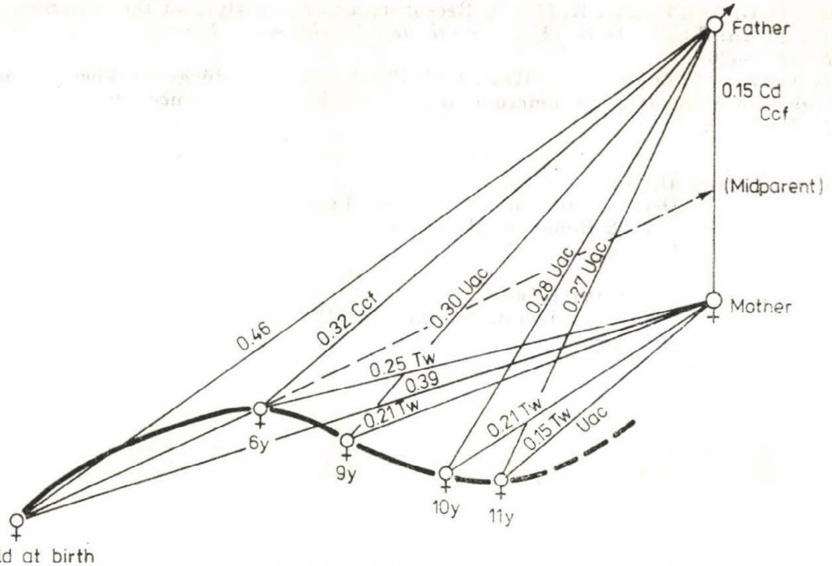


Fig. 4: **The course of the growth of a girl "in the system of her parents" (see text)**

time, also the changed spanning this distance appear. Making use of the measurements presented in Table 1, Fig. 4 shows the change in the physique of a daughter of a couple of parents during the growth process.

Also the phenomena which occur when the given metric is being used for determining the "diameter", i.e. the maximum of the distance by pairs between the elements of a functional group are most interesting. At such times, namely, the diameter of the group will be determined by just the measurements that are the least relevant as to classification, i.e. by the ones which, in spite of the classification into groups change most freely.

By way of *summary* the authors wish to point out that the metric put forward by them is indeed a metric; this has been mathematically cleared. Though complicated, in the course of its use it has proved to come closer to intuition than Pythagorean distance. Even the experience gained up to now demonstrates that the question of metric is worth dealing with since it is a rather promising field. The initial results achieved up to the present denote that further research in that direction may render really correct quite a number of results attained by less exact methods earlier, and that a detailed elaboration of the method may help with the recognition of further new biological relationships.

REFERENCES

Bod, P. (1978): A preferencia-függvényekben szereplő súlyok egyszerű meghatározásáról (On a simple determination of weights in preference functions). — Szigma *11;* 219—221.

Eiben, O. G. (1969): Általánosított koordináták antropológiai alkalmazása (Anthropological application of generalized coordinates). — Anthrop. Közl. *13;* 103—120.

— (1972): *The Physique of Woman Athletes.* — The Hungarian Scientific Council for Physical Education, Budapest, p. 190.

EIBEN, O. G.—CSÉBFALVI, K. (1977): Recent data to the analysis of the variations of physique. — *In:* EIBEN, O. G. (Ed.) *Growth and Development; Physique:* Symp. Biol. Hung. *20;* 417—430.

MIHÁLYFFY, L.—PÖLÖSKEI, P.—RÉTI, J. (1978): A preferencia-függvényekben szereplő súlyok meghatározásáról (On the determination of weights in preference functions). — Szigma *11;* 211—218.

Authors' addresses: Dr. EIBEN OTTÓ
Dept. Anthropology, Eötvös Loránd University
H-1088 Budapest, Puskin u. 3.
Hungary

CSÉBFALVI KÁROLY
H-1117 Budapest, Karinthy u. 13.
Hungary

Anthrop. Közl. 24; 77—82. 1980.

PHYSIQUE OF ENDOGENOUS PSYCHOTIC FEMALE PATIENTS

by O. G. EIBEN, A. KELEMEN, B. PETHŐ and Á. FELSŐVÁLYI

(Department of Anthropology, Eötvös Loránd University, Budapest, Hungary; Budapest VIII. Institute of Mental Hygiene, Budapest, Hungary; Psychiatric Clinic, Semmelweis University Medical School, Budapest, Hungary; Computer Unit, Semmelweis University Medical School, Budapest, Hungary)

Abstract. In the light of the basic findings of KRETSCHMER's somatoscopic school of psychiatric motivation (that namely the leptosome physique displays close connection with schizophrenia and the picnic one with the cyclic psychoses) the authors have made an attempt at classifying the endogenous psychotic patients on a phenotypic basis. For establishing the clinical diagnoses they used LEONHARD's classification. The sample examined by them consisted of 168 female patients, the age of whom varied between 18 and 63 years; all were Hungarians. Over and above comparing the cyclic psychotic and schizophrenic groups, they formed three subgroups within the schizophrenic form (cyclophrenia, systemic schizophrenia, non-systemic schizophrenia). They elaborated the somatometric data by means of cluster analysis and determined the phenotypes of the patients with HEATH—CARTER's method. They found significant differences between the single subgroups and, on the basis of their results they outline a sketch of succession among the different constitutional data of the endogenous psychotic patients.

Key words: physique, endogenous psychotic female patients, systemic schizophrenia, non-systemic schizophrenia, cycloid psychosis.

Introduction

It is a well-known fact, that a fundamental connection has been found by KRETSCHMER (1931) between the mental disorder and the physique of the patient, that can serve as a theoretical starting point of any typological approach. BUDAY (1943) in his monograph about constitution underlined the role of physique in medicine. Let us refer to one of his illustrations (Fig. 1) which, founded on data of 10.000 medical case histories, demonstrates diseases with positive correlation. An earlier examination (KELEMEN—PETHŐ—FELSŐVÁLYI 1977) indicates the existance of constitutional differences within the group of schizophrenic diseases. The aim of our present examinations is:

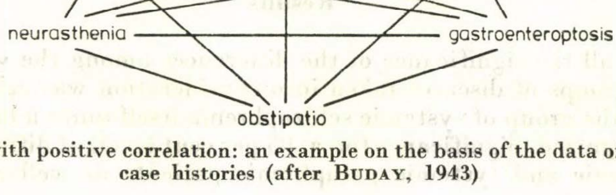


Fig. 1: Diseases with positive correlation: an example on the basis of the data of 10.000 medical case histories (after BUDAY, 1943)

1. the collection of fundamental constitutional data, about the subgroups of endogenous psychoses;

2. the reexamination of a hypothesis according to which, between the victims of the two main groups of endogenous psychoses — i.e. melancholic psychoses and schizophrenia — there are constitutional differences. In our opinion this fact is important either from a psychiatric or from a human biologic point of view.

Material and Methods

To diagnose with prognostical efficiency according to LEONHARD's (1957) method and to follow up the pathologic process is reasonale, because with their help one may differenciate the various supposed groups of diseases within the heterogenous spectrum of schizophrenia. Three groups of diseases within the circle of schizophrenia are dealt with in the present paper:

1. *systemic schizophrenia* with gradual aggravation (33 hebephrenic, 11 systemic catatonic and 26 systemic paraphrenic patients);

2. *non-systemic schizophrenia* with periodic aggravations and recoveries (23 affect-paraphrenic and 16 periodic-catatonic patients);

3. *cycloid psychosis (cyclophrenia)* with long symptomless periods between two relapses following one another. The diseases with such courses are generally regarded as mixed forms of maniac-depressive psychosis and schizophrenia (28 such patients were examined).

In addition to this, we examined 29 melancholic patients (from these there were 15 manic-depressive ones).

Our sample was taken from among the patients of the Psychiatric Clinic Semmelweis University Medical School, Budapest, and consists of 168 female patients. Their age is between 18 and 63 years. They are all Hungarian belong to the Europid race and each of them suffers from endogenous psychosis. In this sample there are 3 psychotic patients (one melancholic and two schizophrenic) who cannot be fitted in either of the previously mentioned groups. 63 measurements — among others 7 head and face measurements — were taken of each of them.

It seems necessary to increase the number of our sample because more detailed subdivisions would be required in the future. Recently the HEATH—CARTER anthropometric typization (CARTER 1975), and, with the purpose of obtaining information on the accumulation of the data, a hierarchic cluster analysis has been carried out by means of the R-20 type computer of the Computational Technological Department of the Semmelweis University Medical School in Budapest. Besides this, we also determined the somatotype of the patients suffering the various psychotic diseases.

Results

I. First of all the significance of the differences among the various features of the four groups of diseases taken into consideration was calculated.

1. Within the group of systemic schizophrenia itself quite a lot of differences could be recognized. Significance (on a .05 per cent level) of differences between the hebephrenic and systemic paraphrenic patients as well as between the

systemic catatonic and paraphrenic patients was manifested in 28 features. In both respects the measurements of width, circumference and skin folds proved to be considerably larger in case of paraphrens.

2. Within the group of the non-systemic schizophrenic patients definitive divisions could not been recognized. Their isolation from the melancholic group, as well as, from the group of systemic paraphrenics seemed to be pronounced.

3. The cyclophrenics significantly differ from the systemic paraphrenics in 15 features. However, their measurements of height surpass those of the paraphrenics; their measurements of width and of skin folds are falling behind those of the paraphrenics. The cyclophrenics differ from the hebephrenics mostly in respect of height; in general, the cyclophrenic measurements are larger (but the situation is reversed in case of the measurements of width). This tendency was more expressed in an earlier assesment (KELEMEN et al. 1977).

4. In melancholic patients no substantial differences can be proved between monopolar (or: periodic) depression and psychosis maniaco-depressiva, and both show few significant differences only, in contrast to the group of cyclophrenics.

5. Comparing the 29 melancholic patients with the 139 schizophrenic ones, significant differences proved to exist also in the measurements of width, circumference and skin fold (the greater measurements are taken from the melancholics).

II. The cluster-formation calls attention to the circumstance that to deviding our sample into too small subgroups would be unworthy. On the level of the 5.441 intergroup value four units can be formed (the figure in parentheses stands for the number of individuals belonging to the given group):

1st group: mainly depressive (5) and manic-depressive (8) patients, as well as systemic paraphrenic (6) ones;

2nd group: cyclophrenic (17) group with systemic catatonic (3), hebephrenic (7), periodic catatonic (5), affect-paraphrenic (3), depressive (4) patients;

3rd group: systemic paraphrenic (11) group with systemic catatonic (2), periodic catatonic (2), manic-depressive (4) patients;

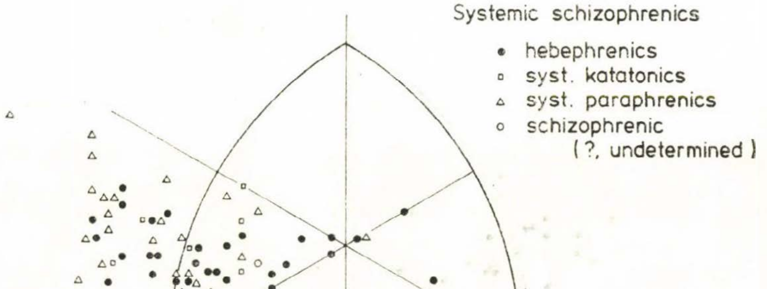


Fig. 2: Somatotypes of the systemic schizophrenic female patients

4th group: hebephrenic (16) group with systemic catatonic (5), periodic catatonic (7) patients.

III. The anthropometric somatotyping of our patients, has been carried out (CARTER 1975). A further qualitative analysis on the basis of standard photos (SHELDON et al. 1940) is in progress. The results yielded by somatotyping do not indicate appreciable differences among the groups, moreover, no well-defined differences can be recognized when comparing them with the data of fertile females taken as control group, either (EIBEN—SÁNDOR—LÁSZLÓ 1974) (Figures 2—6).

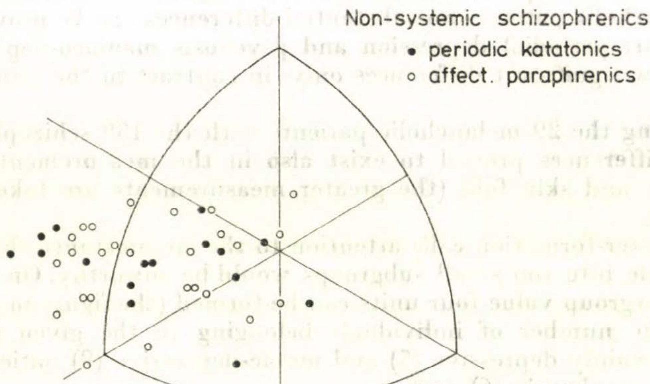


Fig. 3: Somatotypes of the non-systemic schizophrenic female patients

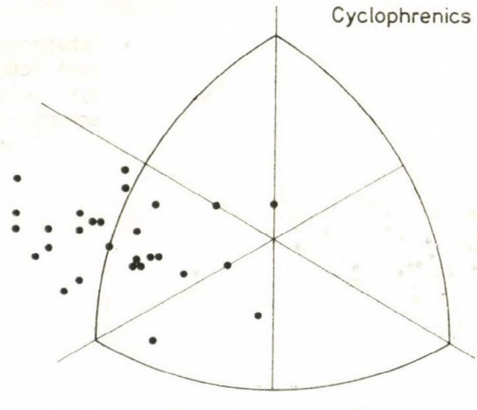


Fig. 4: Somatotypes of the cyclophrenic female patients

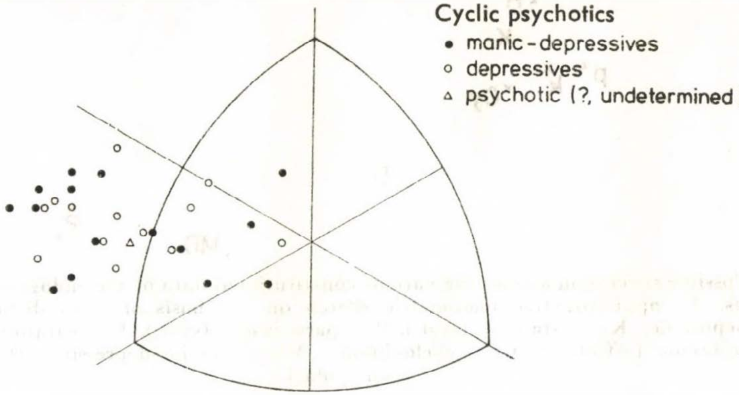


Fig. 5: Somatotypes of the depressive female patients

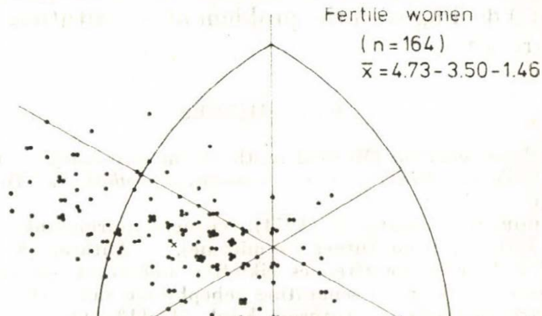


Fig. 6: Somatotypes of fertile women (EIBEN et al. 1974)

Discussion

1. The measurement differences among the various groups generally refer to the values of width, circumference and skin fold.

2. The absolute values of the measurements are largest in the systemic paraphrenic and smallest in the hebephrenic patients. Thus the group of systemic schizophrenic parents is definitely divided into subgroups.

3. The differences among the various groups — relying on the results of the *t*-test — outline the following line of succession: *systemic schizophrenia* — *non-systemic schizophrenia* — *cyclophrenia* — *melancholic diseases.*

4. This linear sketch can be logically modified with a view to the results of the cluster analysis, as shown in Fig. 7.

5. However, the results of somatotyping did not refer to expressed differences among the various groups; the comparison of the body measurements (primarily the data of the subcutan fat) in the melancholic patients shifts towards endomorphism.

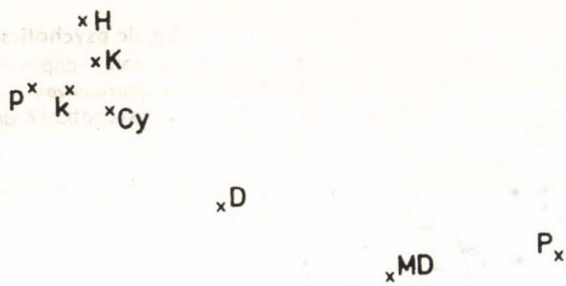


Fig. 7: Possible succession among the various constitutional data of the endogenous psychotic subgroups. An approximative planimetric sketch on the basis of main distances, where H = hebephrenic, K = catatonic (syst.), P = paraphrenic (syst.), k = catatonic (periodic), p = paraphrenic (affective), Cy = cyclophrenic, MD = maniac-depressive, D = depressive (monopolar)

The aim of this paper is to report on the present state of our work far-reaching programme (a manifold, catamnestic examination of endogenous psychotic patients) dealing with the problem of constitution, and to summarize our preliminary results.

REFERENCES

BUDAY, L. (1943): *Orvosi alkattan* (Medical textbook on physique). — Budapest, 414 p.

CARTER, J. E. L. (1975): *The Heath — Carter somatotype method.* San Diego State University, San Diego. 190 p.

EIBEN, O. G.—SÁNDOR, G.—LÁSZLÓ, J. (1974): Turner-syndromások testalkata (The physique of patients suffering from Turner's syndrome). — Anthrop. Közl. *18;* 41—48.

KELEMEN, A. (1977): Kísérlet hebefrén és ciklofrén nőbetegek szomatometriai módszerrel történő elkülönítésére (Attempt at separating hebephrenic and cyclophrenic female patients with a somatometric method). — Anthrop. Közl. *21;* 113—114.

KELEMEN, A.—PETHŐ, B.—FELSŐVÁLYI, Á. (1977): Somatometric and personality-typologic investigations in two groups of schizophrenics. — *In:* EIBEN, O. G. (Ed.): *Growth and Development; Physique.* — Symp. Biol. Hung. *20;* 471—478.

KRETSCHMER, E. (1977): *Körperbau und Charakter* (26th ed.). — Springer,Berlin—Heidelberg—New York. 387 p.

LEONHARD, K. (1957): *Aufteilung der endogenen Psychosen.* — Akademie, Berlin.

SHELDON, W. H.—STEVENS, S. S.—TUCKER, W. B. (1940): *The Varieties of Human Physique.* — Harper and Brothers, New York—London. 347 p.

Authors' addresses: Dr. EIBEN OTTÓ
Dept. Anthropology, Eötvös Loránd University
H-1088 Budapest, Puskin u. 3.
Hungary

Dr. KELEMEN ANDRÁS
H-1022 Budapest, Lévay u. 9/b
Hungary

Dr. PETHŐ BERTALAN
Clinic of Psychiatrics, Semmelweis University Medical School
H-1083 Budapest, Balassa u. 6.
Hungary

Dr. FELSŐVÁLYI ÁKOSI
Computer Unit, Semmelweis University Medical School
H-1083 Budapest, Kulich-tér 5.
Hungary

Anthrop. Közl. 24; 83—89. 1980.

CHANGES IN THE AGE AT MENARCHE OF SOUTHERN-HUNGARIAN GIRLS DEPENDING ON THE OCCUPATION OF THE PARENTS

by G. FARKAS

(Department of Anthropology, József Attila University, Szeged, Hungary)

A b s t r a c t. The author surveyed data collected in Hungary between 1958 and 1978 on the dependence of the age at menarche of girls on the occupation of their parents (both father and mother). The analysis unequivocally proved the fact well-known from the literature that the age at menarche of daughters coming from families where the parents had higher (university- or academic) qualifications, ensued earlier than with girls from families in which the parents were less educated.

The observations are first of all of practical significance, when the time of sexual education at school is being determined.

The author stresses, besides, that valid data of this kind can only be expected from further studies to be conducted with these special objectives in view, as view, as the correct analysis of data is greatly hindered by the circumstance that checking takes rather a long time.

Key words: age at menarche, Southern-Hungary, occupation of the parents.

Introduction

The number of observations concerning the menarche of girls is very high on a world scale. In several countries this indicator of the pubescence of girls has been studied by the researchers in a wide variety of respects.

After surveying the international literature it turns out that these respects can essentially be classified into four groups. There are: (1) questions connected with social factors, (2) bodily endowments affecting the menarche, (3) the part played by natural factors in the formation of maturation, (4) the effect of other affecting factors on menarche.

Specifying the factors given in group (1), the following may be mentioned among the social effects: (a) the social situation of the individual, in wider sense his conditions in the community, (b) the size of the living space per capita, (c) the occupation and educational level of the breadwinner, generally of the parents, guardians, (d) the way of nutrition and the composition of the food, as factors connecting with the popular usage as well, (e) the number of brothers and sisters, and the order of birth of the girls in the family, as a factor affected by customs, demographical effects, (f) the social effect of the town- and village environment.

In the present report the author should like to deal with only a single one of the social factors in detail: the occupation of parents.

In the special literature the observations concerning the connection between the occupation of the parents and the data of menarche can be classified into two groups.

There are some authors who could not demonstrate any connection between the two factors, as e.g. BER—BROCINER (1964), ROBERTS—DANN (1967), ROBERTS—ROZNER—SWAN (1971), ROBERTS (1977).

On the other hand, another group of authors refer to the fact that, observed according to the occupation of the parents, the menarche median of girls may be of different character, their sexual maturity may follow earlier or later.

Thus ŁASKA-MIERZEJEWSKA (1968, 1970) and MILICER (1968) in Polish girls, RICHTER (1973) in German, BARIŠIĆ—GAVRILOVIĆ (1974) in Croatian, JONCE—GAVRILOVIĆ (1970, 1971—1972) in Macedonian, EIBEN (1968, 1972), BODZSÁR (1975) and FARKAS (in press) in the Hungarian ones found an earlier menarche in daughters of mothers and fathers respectively, of higher educational level.

At any rate, it is to be noticed that the data of the literature rather confine themselves to generalities in respect of occupation. The comparison of data is, therefore, not an easy task.

Material and Methods

Earlier first of all in the territory of Southern Hungary, the author collected data in a number of settlements with the status quo method concerning the age at menarche of the 10—18 years old girls. These have already been published (BOTTYÁN et al. 1963, FARKAS 1962, 1963, 1964, 1964a, 1969, 1970, 1971, 1975, 1978, FARKAS—VARGA 1973), or are in press at present (FARKAS's works in press). The author has evaluated these collections recently, taking into consideration the occupation of the mothers and fathers. When grouping the occupations — just on account of the above-mentioned reason — the author took as starting point also the nomenclature given by the Hungarian Central Statistical Office valid in Hungary at present (KSH, 1975). Accordingly, the author determined the following categories of occupation:

(1) *Physical workers:* those who have some trade, who do physical work as semi-skilled or unskilled workers or labourers, who have no secondary school qualification and who, at best, attended skilled workers' training school after being educated in primary (general) schools. According to the place of work, the author formed further three subgroups: (a) industrial physical workers, (b) agriculturer physical labourers, (c) other physical workers.

(2) The *intellectual* (white-collar) workers, classified into two subgroups on the basis of their education are theffollowing: (a) intellectual workers, with university or academic qualification, (b) other intellectual workers, of middle-(secondary) school education.

(3) *Family members* working in the household: this group has been set up as to specify mothers.

(4) *Old-age pensioners:* in case of both parents, the author placed them into a separate category, — independently of the occupation they had earlier: parents who cannot be classified into the above-mentioned categories any more.

(5) Group 5 was set up for dead parents.

As in most cases the occupations did, of course, not agree regarding both parents, the author separated his sample according to the occupation of mothers and fathers, respectively.

At the evaluation, the number and relative frequency of the menstruating and not menstruating girls, classified into half-yearly age-groups was ascertained, and the latter values were converted, with the help of a table of conversion (WEBER 1961) into probit values. Eventually, in the material arranged in this way the median was determined on the basis of a new calculating operation introduced by the author in an earlier publication (FARKAS 1975), yielding the same result as that achieved with the graphic probit method.

The applied equations are as follows:

$$M_e = \frac{5 - a}{b} \qquad \text{Eq.1.}$$

$$b = \frac{n \cdot \Sigma(x_i \cdot y_i) - \Sigma y_i \cdot \Sigma x_i}{n \cdot \Sigma x_i^2 - \Sigma x_i \cdot \Sigma x_i} \qquad \text{Eq.2.}$$

$$a = \frac{\Sigma y_i - b \cdot \Sigma x_i}{n} \qquad \text{Eq.3.}$$

where n = the number of the age-groups, x_i = age of life, y_i = empirical probit.

Results and Discussion

The distribution of the evaluated data of the investigations in Hungary per settlements is shown in Fig. 1, where also the dates of collecting them ar indicated.

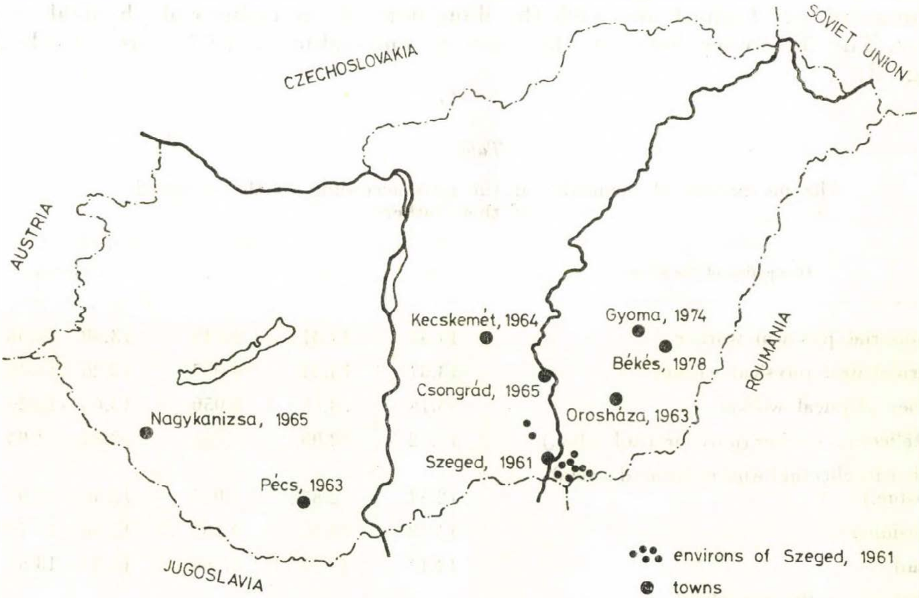


Fig. 1: **Sites and dates of collection of the sample**

In Table 1, the number of elements in the samples and the medians are given, broken down according to the occupation of the fathers and mothers. Of these it appears that on the basis of the occupation of fathers, the data of 6091, on that of mothers the data of 6145 girls were evaluated. For both parents, the medians obtained for the contracted sample are very similar (13.22, resp. 13.25 years). This also approaches very much the national median obtained in 1963 (13.23 years), and evaluated on the basis of 7008 data (Botytyán et al., 1963).

Table 1

Values of the age at menarche of girls in Hungary, according to the occupation of the parents

Occupation of the parents	Father		Mother	
	n	m	n	m
All kinds of occupation, together	6091	13.22	6145	13.25
Industrial physical worker	1877	13.58	901	13.01
Agricultural physical worker	829	13.37	402	13.41
Other physical worker	1600	13.16	1098	13.29
Intellectual worker (of higher education)	757	12.92	164	12.81
Intellectual worker (of middleschool educatio n)	764	12.54	858	12.94
Working in the household	—	—	2666	13.62
Pensioner	128	13.00	—	—
Dead	136	13.17	—	—

According to the occupation of the fathers, the lowest median (12.54 years) occurred with the daughters of the intellectual workers of middle-school education, the highest one with the daughters of the industrial physical workers. The difference between the extreme end-values is 1.04 years (Table 2, Fig. 2).

Table 2

The parameters of menarche of the girls according to the occupation of their fathers

Occupation of the father	m	$\bar{x}$	s_m	$m \pm 1.96\ s_m$
Industrial physical worker	13.58	13.31	0.049	13.48–13.68
Agricultural physical worker	13.37	13.34	0.057	13.26–13.48
Other physical worker	13.16	13.15	0.050	13.06–13.26
Intellectual worker (univ. or acad. educ.)	12.92	12.98	0.059	12.81–13.04
Other intellectual worker (second.school educ.)	12.54	12.83	0.070	12.40–12.67
Pensioner	13.00	13.17	0.162	12.68–13.32
Dead	13.17	13.31	0.169	12.84–13.50
Working in the household	—	—	—	—

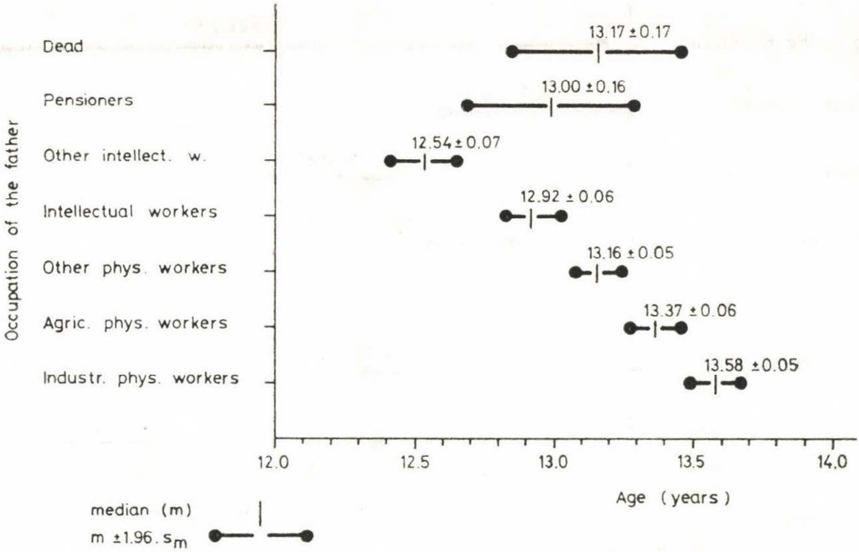


Fig. 2: The medians and confidence intervals of menarche of the girls according to the occupation of their fathers

Viewed from the angle of the occupation of the mothers, the daughters of the intellectual workers of higher education (university or academic) mature earliest, and the daughters of mothers working in the household the latest of all. The difference between the two extreme values is 0.81 years, smaller than when the fathers are considered (Table 3, Fig. 3).

On the basis of all these it can, therefore, be found that there is a difference between the age at menarche of girls according to the occupation of the parents. It seems that in a certain respect this is related with school education, although no data have been collected as to the latter. It is, however, particularly interest-

Table 3

The parameters of menarche of the girls according to the occupation of their mothers

Occupation of the mother	m	$\bar{x}$	s_m	$m \pm 1.95\ s_m$
Industrial physical worker	13.01	13.05	0.064	12.88–13.14
Agricultural physical worker	13.41	13.32	0.111	13.19–13.63
Other physical worker	13.29	13.34	0.030	13.23–13.35
Intellectual worker (univ. or acad. educ.)	12.81	12.83	0.155	12.51–13.11
Other intellectual worker (second. school educ.)	12.94	12.96	0.053	12.84–13.04
Pensioner	—	—	—	—
Dead	—	—	—	—
Working in the household	13.62	13.04	0.529	12.58–14.66

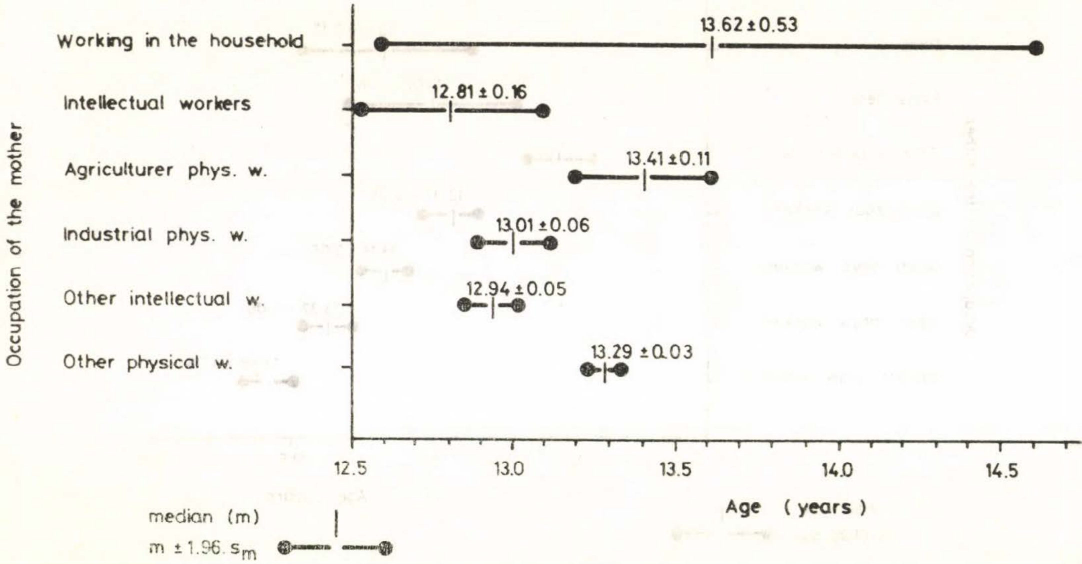


Fig. 3: The medians and confidence intervals of menarche of the girls according to the occupation of their mothers

ing to consider the role of the mothers working in the household in this respect because their daughters mature even later than those of the physical workers.

By what may these differences be brought about?

The effect of the education of the girls can in all probability not be considered primarily responsible for this. It is obvious, namely, that just the mothers working in the household can look after their daughters most, nonetheless, the median is lowest just in case of these, i.e. their daughters mature later. A significant part may be had here by the media of communication (wireless, television, books, daily papers) by their informative effects eliciting psychic stimuli.

It is a fact that also the formation of the average earnings and, generally, the standard of life have a part. This is, by the way, mentioned by many authors, even if not in so unambiguous a conception.

All these observations are of importance — independently of the explanation — in the sexual informative work at school.

In the long run, this is a fact to be taken into consideration even in respect of the transformation of the social structure, because the way of the future is directed towards achieving higher qualifications.

It seems that in the International Year of Children, when the problems connected with their development came into the foreground even more emphasis we ought to lay on these connections.

REFERENCES

BARISIĆ, D.—GAVRILOVIĆ, Ž. (1974): O menarhi kod učenica iz Lipika i Okoline. — Glasn. Antr. Dr. Jug. *12;* 91—98.

BER, A.—BROCINER, C. (1964): Age of puberty in Israelian girls. — Fert. Sterility. *15;* 640—647.

Bodzsár, É. (1975): Data to puberty of girls. — Humanbiol. Budapest. *3*, p. 174.
Bottyán, O.—Dezső, Gy.—Eiben, O.—Farkas, Gy.—Rajkai, T.—Thoma, A.—Véli, Gy. (1963): Age at Menarche in Hungarian Girls. — Ann. Hist.-nat. Mus. Nat. Hung. *55;* 561—572.
Eiben, O. (1968): Das Menarchealter der Mädchen in Westungarn. — Z. Morph. Anthrop. *59;* 273—292.
— (1972): Genetische und demographische Faktoren und Menarchealter. — Anthrop. Anz. *33;* 205—212.
Farkas, Gy. (1962): Az első havi vérzés (menarche) ideje Csongrád megyei leányoknál. — Anthrop. Közl. *6;* 83—105.
— (1963): Orosházi leányok menarche-kora. — Anthrop. Közl. *7;* 129—138.
— (1964): Die Probleme der ersten Blutung (Menarche) und der Auswahl in die Sportschulen. — *In:* Eiben, O. (Ed.) *Internationale Wissenschaftliche Konferenz für Körpererziehung, Budapest 1964.* pp. 120—124. Testnevelési Tudományos Tanács, Budapest.
— (1964a): Das Menarche-Alter der Mädchen von Südungarn. — Acta Biol. Szeged. *10;* 163—176.
— (1969): Untersuchungsergebnisse an Knaben und Mädchen aus Szeged (Südungarn) unter besonderer Berücksichtigung der Reifungsmerkmale. — Wiss. Z. Humboldt-Univ. Berlin. Math.-Nath. R. *18;* 931—940.
— (1970): Neuere Angaben zur Pubertät der tiefländischen Mädchen. — Acta Biol. Szeged. *16;* 109—115.
— (1971): Problem of estimating the coincidence of the month of menarche and the month of birth. — Acta Biol. Szeged. *17;* 185—193.
— (1975): A gyomai gyermekek testi fejlettsége és nemi érése. — Anthrop. Közl. *19;* 97—104.
— (1978): Die Größe der Menarche-Mediane in Ungarn und ihre Beziehung zu meteorologischen Angaben. — Mitt. d. Sekt. Anthr. d. Biol. Ges. d. DDR. *35;* 99—108.
— (1980): Veränderungen der Menarche-Medianwertes nach dem Beruf der Mutter. — Ärztl. Jugkde. *71;* 62—67.
— (in press): Das Menarchealter und die Grösse der Siedlungen. — Anthrop. Közl.
Farkas, Gy.—Hunya, P. (in press): Die körperliche Entwicklung der Kinder in Békés (in ungarisch). — *In:* Dankó I. (Ed.): *Békés néprajza.*
Farkas, Gy.—Varga, I. (1973): Vésztő lakosságának antropológiai arculata. — *Vésztő története.* Vésztő. 505—543.
Jonče, D.—Gavrilović, Ž. (1970): Pojava menarhe kod srednješkolki iz Bitola. — Glasn. Antr. Dr. Jug. *7;* 135—143.
— — (1971—1972): O menarhi devojčica iz Ohrida. — Glasn. Antr. Dr. Jug. *8—9;* 39—46.
Łaska-Mierzejewska, T. (1968): Wiek menarche dziewszat wiejskich z powiatów sanockiego i krósnienskiego. — Przlg. Antr. *34;* 309—316.
— (1970): Effect of ecological and socioeconomic factors on the age at menarche, body height and weight of rural girls in Poland. — Hum. Biol. *42;* 284—292.
Milicer, H. (1968): Age at menarche of girls in Wroclaw, Poland, in 1966. — Hum. Biol. *40;* 249—259.
Richter, J. (1973): Zur Akzeleration der Menarche. Ergebnisse und Schlussfolgerungen aus Untersuchungen an Görlitzer Mädchen. — Ärztl. Jugkde. *64;* 268—280.
Roberts, D. F. (1977): The changing pattern of menarcheal age. — *In* Eiben, O. G. (Ed.): *Growth and Development; Physique.* Symp. Biol. Hung. *20;* 167—175. Akadémiai Kiadó, Budapest.
Roberts, D. F.—Dann, T. C. (1967): Influences on menarcheal age in girls in a Welsh college. — Brit. J. Prev. Soc. Med. *21;* 170—176.
Roberts, D. F.—Rozner, L. M.—Swan, A. V. (1971): Age at menarche, physique and environment in industrial North East England. — Acta Paediat. Scand. *60;* 158—164.
Weber, E. (1961): *Grundriß der biologischen Statistik* (4. Aufl.). — VEB G. Fischer Verlag, Jena.

Author's address: Dr. Farkas Gyula
Dept. Anthropology, József Attila University
H-6701 Szeged, Táncsics u. 2.
Hungary

Anthrop. Közl. 24; 91—98. 1980.

BODY COMPOSITION OF ADOLESCENT BOYS AND GIRLS

by Ž. GAVRILOVIĆ

(Laboratory of Human Biology, Institute of Biology, Faculty of Sciences, Novi Sad University, Novi Sad, Jugoslavia)

Abstract. The relationship between body composition and body weight was investigated in a group of 111 young men and women of seventeen years of age. Specific body weight was calculated according to PASCALE's equation from subscapular skinfold thickness, and the fat percentage of body weight by using the tables by RATHBUN and PACE. From the body weight and fat percentage of body weight the amount of body fat and lean body mass were calculated. These data were compared to results obtained in persons of both sexes, of 20—29 and 60—69 years of age. The seventeen year old persons of both sexes displayed the lowest body weight, body fat and lean body mass values, as well as the smallest subscapular skinfold thicknesses. All of these parameters increase with age, and no difference in lean body mass between the adults of 20—29 and 60—69 years in both sexes was found. The lowest correlation coefficients were found in seventeen year old young men and girls between body weight and subscapular skinfold thickness (0.33), between body weight and lean body mass (0.93). In the same group, the correlation coefficient between body weight and body fat was higher in young men (0.64) than in girls (0.57).

Key words: body composition, subscapular skinfold, adolescent boys and girls.

Introduction

It is well-known that there are methods of analyzing the proportion of the fat amount and lean body mass in the organism. Thus an insight into the body composition of the human organism at the various different stages of ontogenesis is possible. The body weight and the thickness of various skinfolds are used for this purpose, in their basis body composition is determined.

The present study is striving to get insight into the body weight of 17-year-old boys and girls. Body weight refers to the fat amount and lean body mass in the organism.

Material and Methods

Fifty-seven boys and 54 girls, 17 years old, were subjected to the study. Groups of adult individuals of both sexes between 20—30 and 60—69 years of age were taken for comparison. There were 57 men and 114 woman in the 20—30 years old age group. Data of 101 men and 67 women were analyzed in the agegroup of 60—69 years. All studied individuals were natives of the Vojvodina, Jugoslavia.

The results obtained were analyzed by variational statistical methods. The correlation coefficients and regression curves were calculated (HADŽIVUKOVIĆ 1973).

Body weight was measured on a decimal scale and subscapular skinfold thickness with John Bull's calipers applying a constant pressure of 10 gm per 1 sq.mm. of skin.

For calculating the per cent of body fat, the specific body weight was calculated according to the equation of PASCALE L. R.:

$$D = 1.0896 - 0.0179 \cdot x$$

where D is the specific body weight, x the skinfold thickness at the level of the right scapular angle, expressed in centimetres.

The fat content in per cent is obtained by reading off the corresponding values in RATHBUN and PACE's (1945) table of specific body weight. The amount of body fat is calculated from the body weight and the fat percentage in the organism. By subtracting the body fat amount in kilograms from tht body weight in kilograms the lean body mass in kilograms is obtained.

Results and Discussion

Table 1 presents the results of the author's studies of his findings in adult and elder individuals by sex.

Table 1

Body composition according to sex and age

Parameters	♂					
	17		20—30		60—69	
	x̄	SD	x̄	SD	x̄	SD
Body weight, kg	64.94	7.63	71.10	9.14	74.15	13.79
Fat, kg	8.99	2.45	11.91	3.86	14.30	6.69
Lean body mass, kg	55.77	6.13	59.23	6.61	59.52	8.13
Subscapular skinfold, mm	99.12	29.53	134.84	43.71	156.67	65.03
N	57		57		101	

Parameters	♀					
	17		20—30		60—69	
	x̄	SD	x̄	SD	x̄	SD
Body weight, kg	54.89	5.16	61.36	10.72	69.75	10.84
Fat, kg	9.82	2.53	14.28	6.09	20.35	7.53
Lean body mass, kg	45.20	4.41	47.07	6.31	49.40	6.31
Subscapular skinfold, mm	148.44	42.22	206.66	64.60	268.48	83.13
N	54		114		67	

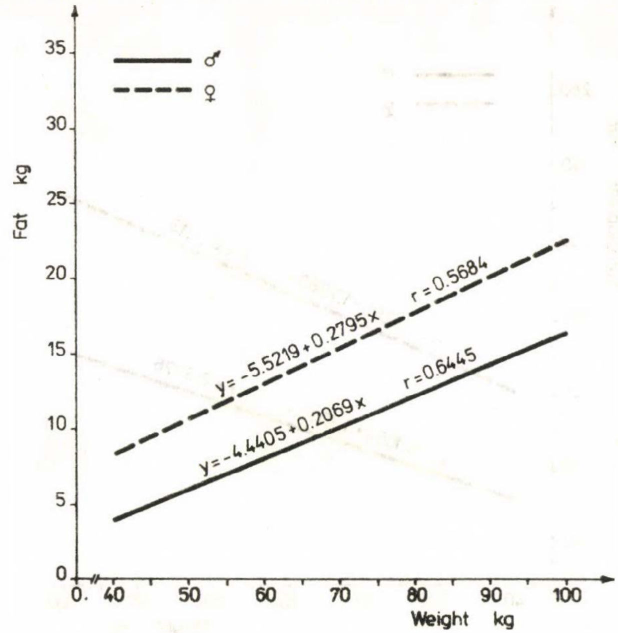


Fig. 1: **Relation between body weight and body fat in 17 year old boys and girls**

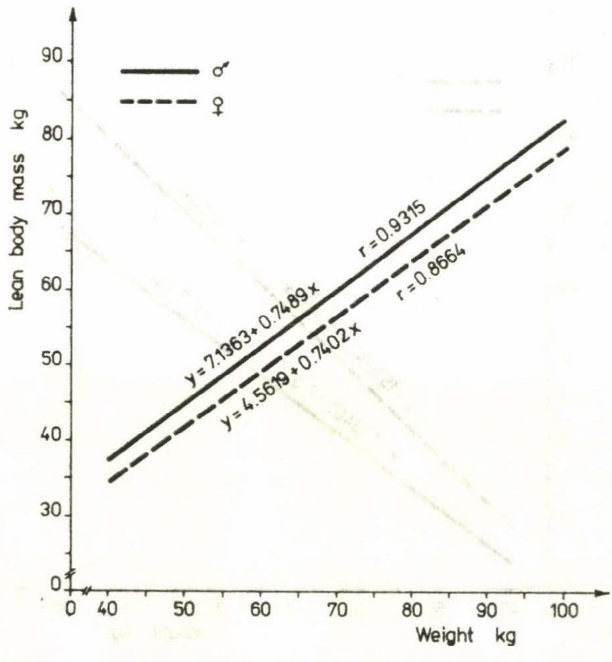


Fig. 2: **Relation between body weight and lean body mass in 17 year old boys and girls**

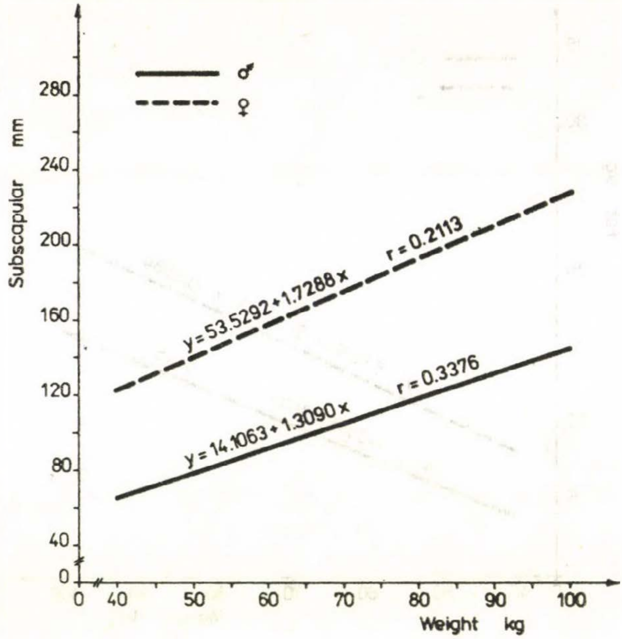


Fig. 3: **Relation between body weight and subscapular skinfold in 17 year old boys and girls**

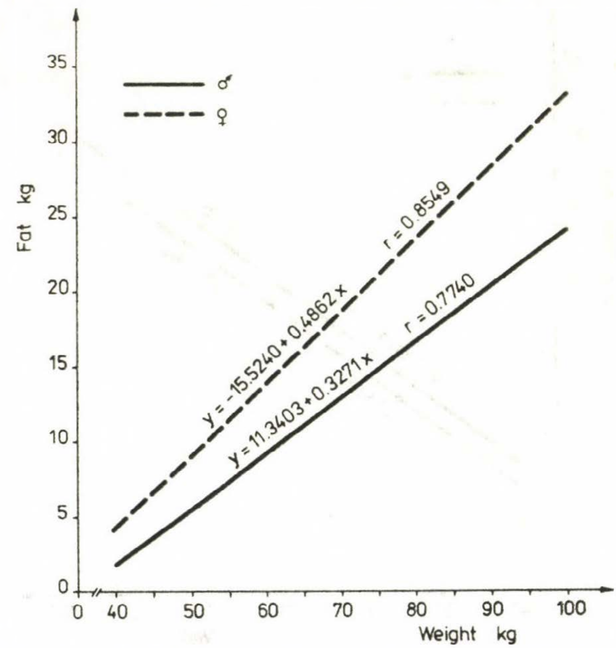


Fig. 4: **Relation between body weight and body fat in 20—30 year old men and women**

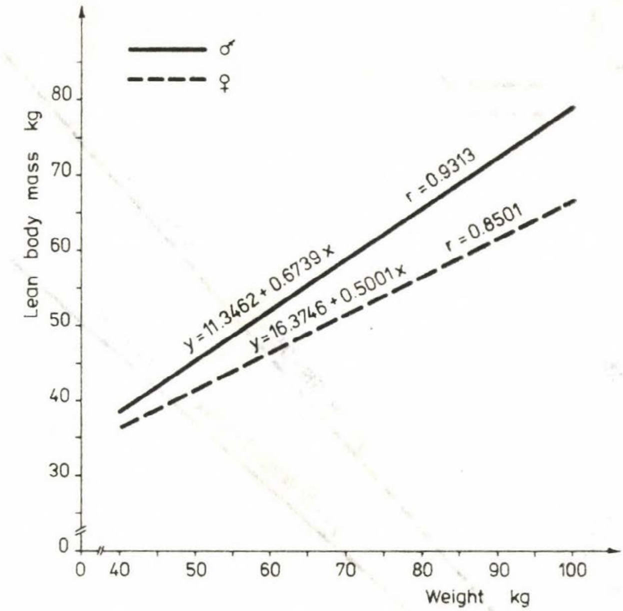


Fig. 5: Relation between body weight and lean body mass in 20—30 year old men and women

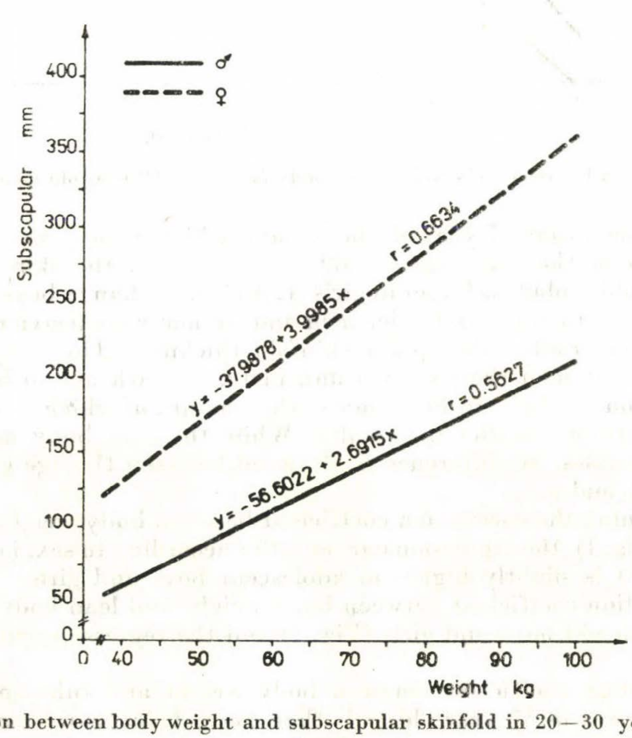


Fig. 6: Relation between body weight and subscapular skinfold in 20—30 year old men and women

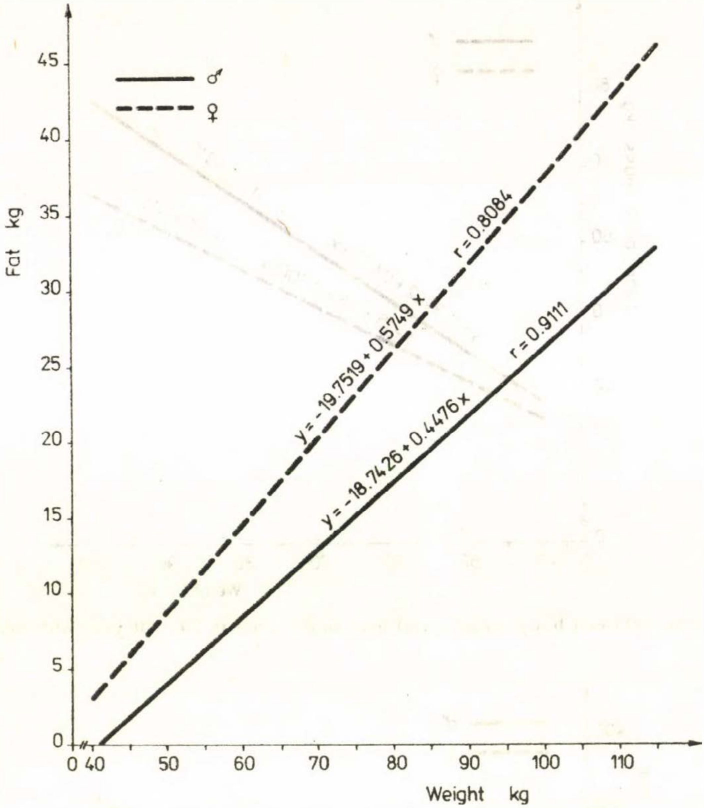


Fig. 7: **Relation between body weight and body fat in 60—69 year old men and women**

It is to be seen that 17 year old boys have a higher body weight (64.94 kg) than the girls of the same age (54.89 kg). However, the skinfold thickness below the shoulder blade is larger in girls (1.4844 mm) than in boys (0.9912 mm). The same applies to adult and older men and women with heavier body weight and more considerable subscapular skinfold thickness. The body fat content is higher in adult men than women and increases with age in both sexes. It has not relation to the lean body mass, the amount of which in the organism is in all age groups smaller in females. While the lean body mass increases with age in females, no difference is observed between the age groups 20—30 and 60—69 in males.

By determining the correlation coefficient between body weight and amount of body fat (Fig. 1), the regression curves differ according to sex, i.e. the correlation coefficient is slightly higher in adolescent boys and girls.

The correlation coefficient between body weight and lean body mass is very high in 17 year old boys and girls (Fig. 2) and the regression curves have the same trend.

The correlation coefficient between body weight and subscapular skinfold thickness is lower in 17 year old girls than boys; being more variable in girls (Fig. 3).

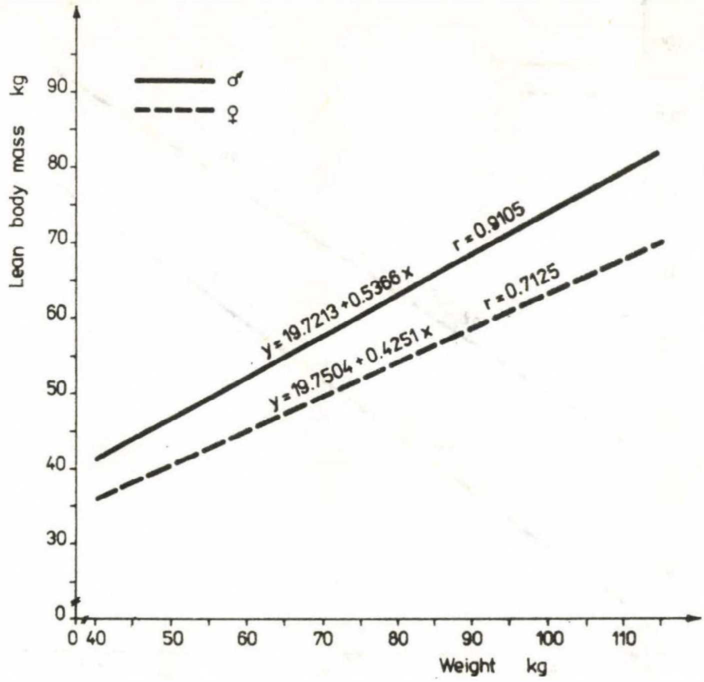


Fig. 8: Relation between body weight and lean body mass in 60—69 year old men and women

In the 20—30 years old of both sexes adults, the correlation between body weight and body fat is much higher than in 17 year old boys and girls, with a considerably higher variability of fat amount depending on the body weight (Fig. 4).

The correlation between body weight and lean body mass in 20—30 year-old individuals is as high as in 17 year old boys and girls (Fig. 5).

However, the correlation between body weight and subscapular skinfold thickness is markedly stronger, being within the limits of the stronger correlation (Fig. 6).

In 60—69 year old individuals the correlation between body weight and body fat amount is very strong in both sexes with higher variability in females (Fig. 7).

The correlation between body weight and lean body mass in older persons is very strong in men and strong in women, with a higher variability of individual findings in males (Fig. 8).

The interrelationship between body weight and subscapular skinfold thickness in the oldest individuals is very strong in men, strong in women, with higher variability of individual values in females (Fig. 9).

The studies set forth here show that adolescent individuals of both sexes differ in their body composition from adults of the age groups of 20—30 and 60—69 years. They display the smallest body weight, body fat amount and subscapular skinfold thickness. Their correlation coefficients between body

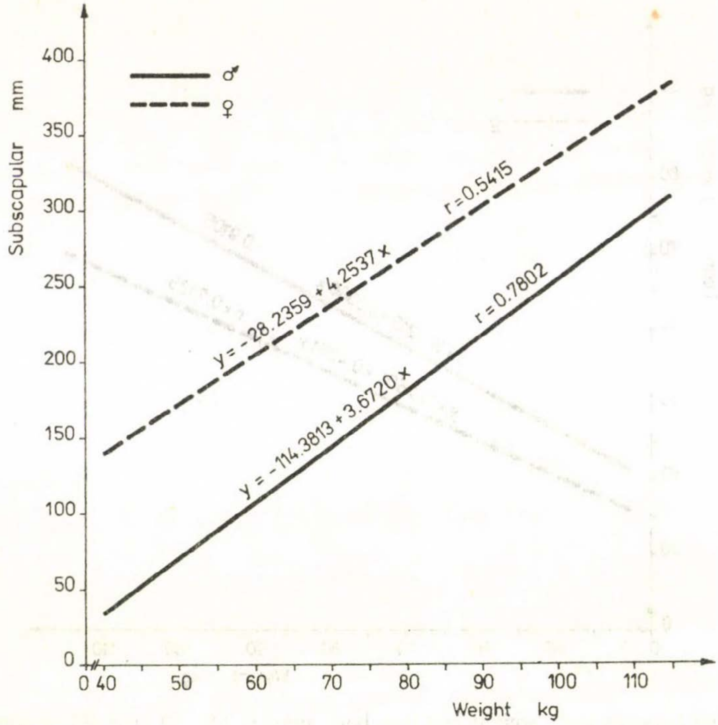


Fig. 9: Relation between body weight and subscapular skinfold in 60—69 year old men and women

weight and body fat amount as well as between body weight and subscapular skinfold thickness, respectively are the lowest. The correlation between body weight and lean body mass is very strong in 17 year old boys and girls, showing a trend to decrease with the increasing age in the females.

REFERENCES

Brožek, J. (1967): Promene sastava čovečjeg tela prema polu i uzrastu za vreme detinjstva i mladosti. — Glas. Antrop. drust. Jug., *4—5;* 15—42.

Pascale, L. R. *cit.* Simić, B. (1960): *Higijena ishrane sa osnovima dijetetike.* — Medicinska knjiga, Beograd.

Rathbun, E. H.—Pace, N. (1945): Studies on body composition. I. Determination of body fat by measure of the body specific gravity. — J. Biol. Chem. 667—676.

Hadživuković, S. (1973): *Statisticki metodi.* — Novi Sad.

Author's address: Prof. Dr. Živojin Gavrilović
Laboratory of Human Biology
Institute of Biology
Faculty of Sciences
Dr. Ilije Buričića Street 6
21000 Novi Sad
Jugoslavia

Anthrop. Közl. *24;* 99—104. 1980.

SOMATIC AND PSYCHOLOGICAL CHARACTERISTICS OF HUNGARIAN FEMALE DRIVERS

by G. Gyenis, G. Héra, K. Endrődi, I. L. Kardos, and O. G. Eiben

(Department of Anthropology, Eötvös Loránd University, Budapest, Hungary; Psychological Laboratory, Budapest Transport Company, Budapest, Hungary)

Abstract. The physique and the psychic characters of 106 Hungarian female drivers working at the Budapest Transport Company as bus-, trolleybus- and underground railway drivers were examined. Somatotypic comparison was made between drivers, and normal fertile women. Psychic characters were examined by the Luscher-, Szondi-, Rotter-, and CPI-tests, and also comparisons between somatic and psychic characters were made.
Key words: physique, psychological characteristics, female drivers, Budapest, Luscher's test, Szondi's test, CPI-test.

Introduction

The steady increase in the number of working women is a characteristic phenomenon of the 20th century.

In societies of mainly agricultural and handicraft character there is no such a marked difference between housewives and females working outside their home, as can be found in industrial countries. It is only in the industrial and servicing branches that female employment, going together with a long absence from home, causes some difficulties in the housekeeping of the family. It can be added that the employment of women in social production widens their social relations, too, giving them an autonomous place and, consequently, a clearer consciousness of their personality.

More and more working places and jobs which were exclusively for men in the recent past have by now been occupied by women, too. For example, in Hungary the first female bus drivers have also began their work this year. This fact gave us the idea to examine some somatic and psychological characteristics of the Hungarian female drivers.

Material and Methods

Our data were collected on 106 Hungarian female drivers working at the Budapest Transport Company as bus-, trolleybus- and underground drivers. The volunteer subjects were of a mean age of 28.3 years, ranging from 18 to 49 years. Somatotyping was made with the Heath—Carter method, while the psychological characters were examined by the Lüscher-, Szondi- and CPI-tests (Lüscher 1969, Furrer 1955, Mérei 1965, Oláh 1979).

Results and Discussion

The Heath—Carter's somatotype describes body morphology as well as body composition, thus it is a very good shorthand description of human physique.

The somatotypes of the Hungarian female drivers are presented in Fig. 1. The majority of the drivers show endomorphy, only some subjects are meso- or ectomorphic. The mean somatotype is not far from the "classic" rate of endomorphy, while the means of the first, second and third components are: 6.83—2.90—1.59, respectively.

The somatotypes of the control fertile women — investigated by EIBEN (EIBEN et al. 1974)—are different from those of the drivers (Fig. 2). Though the majority of the healthy fertile women also show endomorphy, they are next to the border of mesomorphy and several subjects are meso- or ectomorphic. The mean somatotype of the control group is also nearer to mesomorphy. The mean rates of the three components are: 4.73—3.50—1.46, respectively.

Among the psychological tests the results of the Lüscher's test were analysed first. The data of the first subtype of Lüscher's test show that the majority of the female drivers have extrovert personalities because they prefer light shades of colour to dark ones, refusing the latter (Table 1). The rank of the weighted mean of the drivers is different from the Hungarian female standard (RÓKUSFALVY et al. 1971).

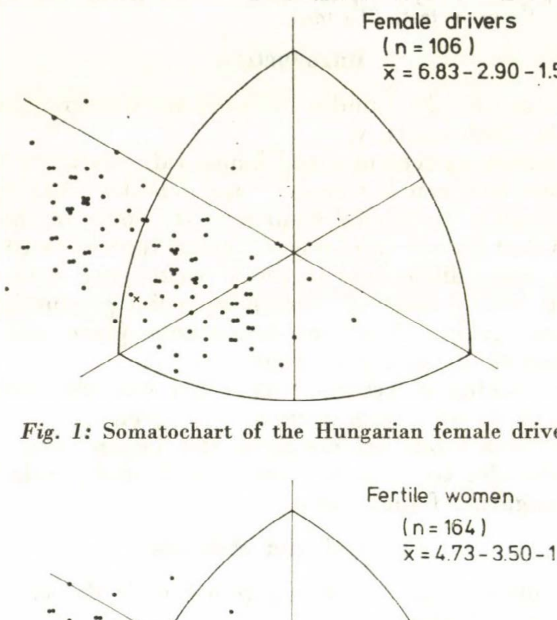


Fig. 1: Somatochart of the Hungarian female drivers

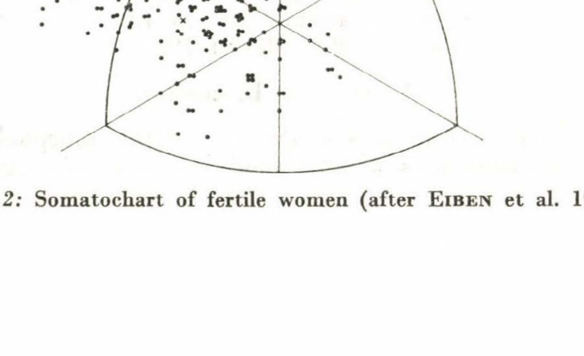


Fig. 2: Somatochart of fertile women (after EIBEN et al. 1974)

Table 1

Lüscher's test: a list of choices of grey colours
(0 = grey, 1 = greyish-black, 2 = black, 3 = greyish-white, 4 = white)

colours \ list of choices	I	I	III	IV	V
0	16	20	24	13	7
1—2	21	21	30	46	41
3—4	43	39	27	19	32

the rank of the weighted mean:

Female drivers	*Hungarian female standard*
0 3 4 2 1	3 0 2 1 4

The data of the second subtype of Lüscher's test (Table 2) similarly indicate the extrovert personalities of the subjects on the basis of their choosing red and yellow colours. Furthermore, they reflect a large vital- and will power as well as a motor activity. The refusal of the grey colour shows a large stimulus and hunger of adventure. The results of the first and second investigations are very similar, which means small vegetative-affective vacillation of tone in female drivers. The female control (Rókusfalvy et al. 1971) is different from our sample.

Table 2

Lüscher's test: the rank of the weighted mean in the choice of 8 colours (0 = grey, 1 = blue, 2 = green, 3 = red, 4 = yellow, 5 = purple, 6 = brown, 7 = black)

a) Female drivers

investigations \ list of choices	I	II	III	IV	V	VI	VII	VIII
First investigation	3	4	2	6	1	5	0	7
Second investigation	3	4	2	6	5	1	0	7

b) Female control
(A = 21—30 years, B = 31—40 years)

	investigations \ list of choices	I	II	III	IV	V	VI	VII	VIII
A	First investigation	3	2	4	5	6	0	1	7
	Second investigation	3	4	2	5	6	0	1	7
B	First investigation	3	2	4	5	0	1	6	7
	Second investigation	3	5	4	0	2	6	1	7

The results of the third subtype of Lüscher's test are very interesting (Table 3). The refusal of the blue and yellow colours is most frequent among the drivers, which reflects a refusal of the heteronomous behaviour.

Table 3

Lüscher's test: the frequency of refused prime-colours

list of choises / prime colours	A_1 (VI)	A_2 (VII)	A_3 (VIII)	Total	
				obs.	%
Blue (1)	8	18	13	39	49.0
Green (2)	3	7	3	13	16.7
Red (3)	6	6	1	13	16.7
Yellow (4)	10	6	4	20	25.0

56.2 per cent of the female drivers refused one prime colour, 22.5 per cent two prime colours and 1.25 percent three such colours.

The values of the vegetative indices (1.66 and 1.50) also show ergotrophic-sympathetic tendencies (Table 4).

Table 4

Lüscher's tests: vegetative indices (o. c. = order of choice)

$$VI_{(8\ \text{colours})} = \frac{\text{o.c. of the red (3) colour} + \text{o.c. of the yellow (4) colour}}{\text{o.c. of the blue (1) colour} + \text{o.c. of the green (2) colour}} = 1.66$$

$$VI_{(\text{columns})} = \frac{\text{score of 0 column } 7.3 + 6.8 \text{ (score of P column)}}{\text{score of I column } 4.4 + 4.9 \text{ (score of D column)}} = 1.50$$

In Table 5 the most frequent constellations of Szondi's test are presented. Of them the *P* and Sch vectors show on the one hand the highest tension of emotionality and on the other the well adjustable function of personality, which is a consequence of the function of the emotional and motoric control.

Table 5

Szondi's test: the most frequent constellations

S			P			Sch			C		
h	s	%	e	hy	%	k	p	%	d	m	%
0	—	22.1	+	—	17.0	—	+	27.3	+	0	15.6
+	—	15.6	+	±	12.0	0	+	14.3	—	+	14.3
—	—	14.3	—	—	10.4	±	0	14.3	0	+	11.7
+	0	9.1	0	—	10.4	±	+	11.7	+	±	7.8

The results of the CPI test of the female drivers (Table 3) fit well into the Hungarian female standard except dominance and femininity which are lower (Figure 3).

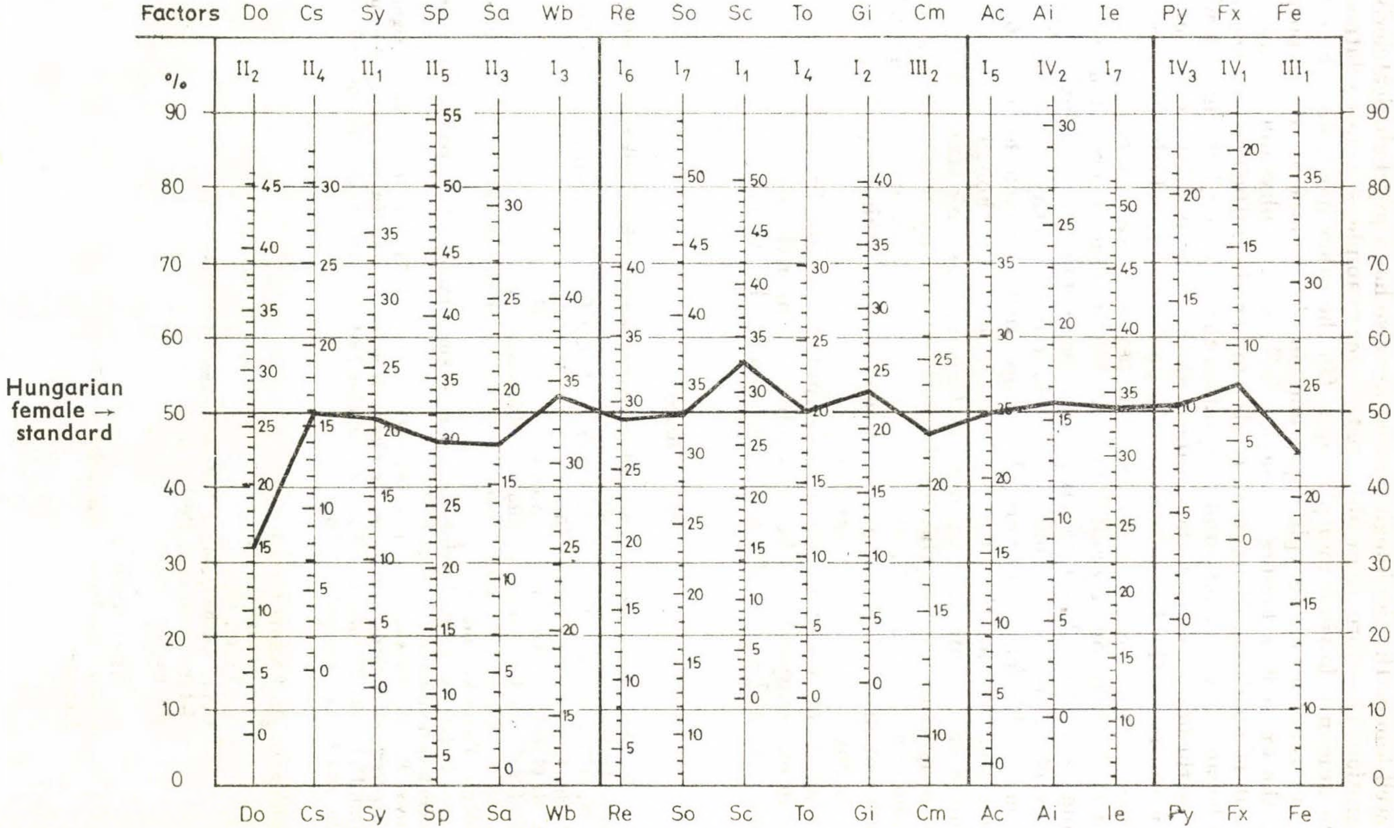


Fig. 3: **The results of the CPI-tests**

It is well-known that a biological structure also has a psychological derivate, or integration. Therefore, there also exists — for example — a close relationship between human behaviour and physique. On the other hand, also the effects of the environment on the physique and on the behaviour are important. Among the exogenous factors — having influence on physique — the most important is nutrition. Behaviour is also under the influence of exogenous factors because it is a function of adaptation the dynamical changes of which depend on the homeostasis of the organism and the effects of the environment.

The majority of the female drivers are endomorphic which indicates that they possess large energy reserves. Our psychological examinations show that indeed their personality and behaviour require much energy. For example, according to FURRER (1955) refusing two prime colours is pathologic, and the frequency of the refusers of one prime-colour in a healthy sample is 7.7 per cent. Among the female drivers this proportion is much higher (56.2%). However, in our opinion these figures do not indicate a pathologic psychological condition of the female drivers, only the large intrapsychic stress which is not equal to a signal of distress. Our opinion is supported by WALLNÖFER's (1968) result who examined his subjects before and after an autogenic training. The rank order of his subjects in choosing colours after training (3 4 2 5 1 6 0 7) is very similar to that of our sample.

Summing it up, we may well assume that it was not by chance that the subjects in our sample have chosen a job requiring rich and adequate models of motion obtained genetically and developed by learning.

REFERENCES

EIBEN, O.—SÁNDOR, G.—LÁSZLÓ, J. (1974): Turner-syndromások testalkata. — Anthrop. Közl. *18;* 41—48.

FURRER, W. (1955): Der Lüscher-test. *In* STERN, E. (Ed.): *Die Tests in der klinischen Psychologie.* 2. Band. — Rascher Verlag, Zürich.

LÜSCHER, M. (1969): *Lüscher-test.* (10. Aufl.) Test Verlag, Basel.

MÉREI, F. (1965): A Lüscher-próba klinikai alkalmazása. Vademecum, *14.*

OLÁH, A. (1979): A kaliforniai pszichológiai kérdőív magyar standardja. — ELTE Általános Pszichológiai Tanszék, Budapest. pp. 89.

RÓKUSFALVY, P. (1963): Az affektivitás szerepe a gépkocsivezetőjelöltek szenzomotoros teljesítményének alakulásában. — Pszich. Tan. V.

RÓKUSFALVY, P.—POVÁZSAY, É.—SIPOS, K.—HALMI, GY. (1971): *Az affektivitás vizsgálata. A Lüscher-teszt alkalmazási lehetőségei és standardizálása.* — Akadémiai Kiadó, Budapest.

WALLNÖFER, H. (1968): *Die autogene Norm des Lüscher-Test zur Kontrolle des Therapieerfolgs.* — Hoffman und Campe-Verlag, Hamburg.

Authors' addresses: Dr. GYENIS GYULA
L. KARDOS ILDIKÓ
Dr. EIBEN OTTÓ
Dept. Anthropology, Eötvös Loránd University
H-1088 Budapest, Puskin u. 3.
Hungary

Dr. HÉRA GYÖRGY
H-1117 Budapest, Karinthy u. 17.
Hungary

Anthrop. Közl. *24;* 105–117. 1980.

PRIMARY AND SECONDARY CATECHOLAMINE EXCRETION IN NORMAL AND AUTISTIC CHILDREN

by H. HELEVUO

(Department of Biological Anthropology, Oxford University, Oxford, England)

Abstract. In a study designed to investigate in detail the interactions between an individual's behaviour and physiology, urinary catecholamines were used as the endocrinological parameter. In addition to the primary catecholamines, epinephrine and norepinephrine, the concentrations of the major products of their metabolism; metanephrine, normetanephrine and vanillyl mandelic acid were measured to establish whether the excretion rates of the primary, most commonly measured, catecholamines accurately reflect secretory activity.

It was established that both normal and autistic children have their own endocrine "signatures". Metanephrine and normetanephrine excretion rates were found to co-vary with those of their percursors.

Key words: primary catecholamines, secondary catecholamines, normal children, autistic children.

Introduction

This study combined two branches of science, ethology and endocrinology, to investigate in detail the interactions between an individual's behaviour and physiology. The report here concentrates on the endochrinological results as other aspects of the study are reported in this volume by V. REYNOLDS.

The study included autistic as well as normal children. The reason for this was that if links were to be established between physiological processes and behaviour patterns, then comparison of two groups known to differ behaviourally might show the physiological differences up clearly. Additionally, it has been suggested that autistic children's aberrant behaviour is a 'stress' phenomenon. This also argued for the inclusion of an autistic group, because the physiological measure used here, catecholamine excretion, has often been used as an indicator of physical and mental stress.

Urinary rather than plasma catecholamines were measured in this study for two reasons. Firstly, it was illegal to take blood samples from children except for medical purposes. Secondly it was known that the drawing of blood samples could in itself cause stress and would elevate catecholamine levels (CARRUTHERS et al. 1970). In any case, the short biological half-life of the catecholamines made urinary measurement attractive, since it was possible to devise the behaviour recording method so that it overlapped this half-life many-fold.

Most investigators hitherto measured only the unmetabolized urinary catecholamines, epinephrine (E) and norepinephrine (NE) (FRANKENHAEUSER 1971, BARCHAS et al. 1972). However, over 90% of the catecholamines secreted into the blood had been shown to be metabolized before they reached the urine (NAGATSU 1973). Therefore, previous studies had ignored by far the largest component of the total urinary amine pool.

It was decided that in the present study the immediate breakdown products of E and NE, metanephrine (MN) and normetanephrine (NMN) would also be measured in order to obtain more accurate information about the rate at which E and NE were secreted into the circulation. Furthermore, it was decided to measure the concentration of the final breakdown product of all the catecholamines, vanillyl mandelic acid (VMA). Such measurements might provide further confirmation of the total secretion rate.

Five to seven year-old children were chosen because it was felt that they were likely to display natural behaviour patterns in a classroom. The normal group for the first year of study consisted of five boys and five girls aged between five and six at Overmede School. For the second year of study ten boys and ten girls aged between five and seven were observed at New Marston School. The autistic group studied during the first year consisted of four boys aged between seven and ten, attending Smith Hospital School. The autistic groups for the second year of study consisted of one girls and nine boys aged between five and eleven years who attended Smith Hospital School and eight boys aged between five and thirteen who attended Springhallow School.

Material and Methods

Data collection procedure

The first year's data collection was carried out during summer term 1974 and the second year's data collection during autumn term 1975. Slight modifications in the methods were made for the second data collection in the light of the results of the first year's study.

First year sample

In the summer term 1974 behaviour recordings were made and urine samples collected from each of the normal children during the morning of two separate three day periods. The data for each of the autistic children were collected on five separate days in the early afternoon on every second Monday and Wednesday during the ten-week term.

The daily routine was as follows: The observer arrived at the school half an hour before observation commenced with the nurse who assisted with the urine collection. Once the children were in the classroom, they were all sent as a routine measure to the toilet to empty their bladders. The nurse recorded the time of urination for each child and discarded all the urines. When the children were back in the classroom, behaviour recordings were made continuously on the two pre-selected children for the next 1 to 2 1/4 hours.

If, during the observation period, any of the children wished to go to the toilet, the child would go to the nurse and use his/her personal potty. The observation period was ended at a convenient point, just before the lunch or play break. At this time the children were all sent to the toilet by the teacher as part of the normal school routine. The children then used their potties for the last time on that day, this final time was also recorded by the nurse.

The nurse knew which two children were being observed on every occasion and kept and pooled all urine samples collected from these children during the observation period. The nurse discarded urine collected from the children not under observation. The children did not know who was being observed and which urines were being collected.

In the final three-day period of the study on normal children and in the last week of the data collection for autistic children, all children were given bottles and collection instructions to take home so that night samples could be collected. The parents helped their child to collect overnight samples for three successive nights. They were asked to record the time of the child's last urination before going to bed, whether the child urinated during the night and if so when, and the time of first urination on awakening. This urination was pooled with any that occurred during the night and brought to school with the time slip the next morning.

Second year sample

During the second year of data collection the daily routine of concurrent behaviour recordings and urine collection was carried out in exactly the same way as in the first year data collection. This time, however, because of the possible error introduced by collecting the normal and autistic children's urine samples at different times of day, the data for *both* normal and autistic groups were collected in the mornings.

One of the main aims of the second data collection was to increase the sample size and, therefore, it was decided to collect four consecutive days' data for each child, thus reducing the total time required for data collection. The night samples were collected for three nights before the days on which the child was to be observed.

These modifications made it possible to collect the data on the twenty normal children in the first half of the autumn term, and on the eighteen autistic children in the second half of the same term. The collection resulted in four day behaviour recordings with four concurrent urine samples and three night urine samples for each child.

Preliminary processing of urine samples

During both data collections the urine samples were processed immediately as follows:

The volumes of urine samples were measured and noted. Aliquots were preserved with 5% sodium metabisulphite for the E and NE analyses and with 2.5N hydrochloric acid for the MN, NMN and VMA analyses. The aliquots (now at pH 1—2) were flash frozen on solid carbon dioxide, transported frozen to the laboratory and stored at —18 °C until analysis. All analyses were carried out within six months of the data of collection.

Biochemical methods

1. *Analysis of urinary epinephrine*

A slight modification of the method originally described by McCullough (1968) using the trihydroxyindole reaction was used in this study.

2. *Analysis of urinary metanephrine and normetanephrine*

The method of Anton and Sayre (1966) was selected for use in this study after careful consideration and comparison of all possible methods. Some minor modifications to the method were necessary because of the different fluorimetric apparatus available (the Aminco Bowman SP 125 instead of the Aminco Bowman Spectrophotofluorometer) and also because of other slight differences in laboratory equipment. Later, when handling the even larger number of urine samples collected during the second year of study, it was necessary to increase the number of samples analysed per day. Therefore, during the extraction steps, a mixture of acetone and solid carbon dioxide was used for flash freezing to allow quicker separation of organic and inorganic phases.

3. *Analysis of urinary vanillyl mandelic acid*

The method of Pisano and co-workers (1962) was sensitive enough to be used to monitor catecholamine metabolism in normal subjects, and a slight modification of this method was used to measure urinary VMA concentrations during this study.

Results

I. THE FIRST YEAR: SMALL SAMPLE

Inter- and intra-individual variation in catecholamine excretion rates

Hierarchal analysis of variance was used to assess inter- and intra-individual variations in catecholamine excretion rates. These variances were calculated both for day and night values of each catechol. A comparison was also made between mean excretion rates during the day and at night.

Epinephrine

Three points emerged from these results:

(1) Intra-individual variation in excretion rates was less than the inter-individual variation during the day period ($p < 0.05$). In other words individuals exhibited consistancy in E excretion. This confirms the findings of Pátkai and Frankenhauser (1964).

(2) Individual consistency was also found to be significant during the night ($p < 0.05$).

(3) The day period means were generally higher than the night period means. It was also apparent that there was a tendency for individuals with consistently higher day values also to exhibit higher night values.

Metanephrine

MN excret on rates followed exactly the same pattern as E excretion rates, but the significance of individual consistency during the day and night periods was greater ($p < 0.01$ in both cases).

Norepinephrine

NE excretion rates followed a diffetent pattern from that of E and MN:

(1) Intra-individual variation in the excretion rates was not less than the inter-individual variation during the day period. In other words individuals did not exhibit consistency in NE excretion.

(2) Intra-individual variation in the excretion rates was, however, less than the inter-individual variation during the night ($p < 0.01$).

(3) Day means were higher than night means, but there was no tendency for an individual with high day values to show high night values.

Normetanephrine

NMN excretion rates followed the same pattern as those of NE, except that for NMN there was no individual consistency in the night excretion rates.

Vanillyl mandelic acid

The following points were established:

(1) Intra-individual variation in the excretion rates was less than inter-individual variation during the day period ($p < 0.01$).

(2) Individual consistency in excretion rates was also found to be significant during the night period ($p < 0.05$).

(3) Day period means were higher than night period means. There was a slight tendency for individuals with high day values to show high night values.

Summary of results

A clear picture emerged after the measurement of the excretion rates of the five related catechols. E and its breakdown product MN followed a pattern of excretion which was consistent for an individual, while NE and its breakdown product NMN did not show such consistency. VMA, the common breakdown product of E and NE was, like E and MN, excreted in a consistent manner by an individual.

Sex differences in excretion rates

The data for the normal group were analysed for sex differences using the Mann-Whitney U test (this was not possible for the autistic group as it consisted entirely of boys). No sex differences in excretion rates were found for day period samples. Two sex differences were found in MN excretion rates. Boys excreted significantly higher levels than girls during the night period ($p < 0.05$) while girls showed larger increases in excretion rates from night to day ($p < 0.05$).

Correlation of the excretion rates of the primary amines and their breakdown products

The Spearman rank correlation test was used to analyse the excretion rate data. The aim was to establish whether the excretion rates of the primary catecholamines co-varied with those of their metabolites, which were excreted in much greater quantity.

Table 1

Correlation of excretion levels of epinephrine to metanephrine and norepinephrine to normetanephrine (Spearman rank correlation, N = 14)

Hormones	Time of day	r_s	Level of significance
E → MN	day	0.516	$p < 0.05$
	night	0.499	$p < 0.05$
	day/night	0.231	ns
NE → NMN	day	0.073	ns
	night	0.257	ns
	day/night	0.129	ns

The results are presented in Table 1. There was a positive correlation between the excretion rates of E and its metabolite MN both during the day and the night ($p < 0.05$ in each case). The ratios of day to night levels did not show this correlation. No correlation was found between the excretion rates of NE and NMN.

II. THE SECOND YEAR: LARGE SAMPLE

Inter- and intra-individual variation incatecholamine excretion rates

Inter- and intra-individual variations in catecholamine excretion rates were assessed using a hierarchal analysis of variance. Variances were derived from this analysis for both day and night values of each catechol. The mean day and night excretion rates of the catecholamines were also compared.

Epinephrine

The same three points emerged from these results as had been noted in the first year:

(1) Intra-individual variation in excretion rates during the day period was less than inter-individual variation ($p < 0.01$).

(2) Individual consistency was also found to be significant during the night ($p < 0.01$).

(3) The day period means were generally higher than the night period means. It was also apparent that there was a tendency for individuals with consistently higher day values also to have higher night values.

Metanephrine

MN excretion rates followed exactly the same pattern as E excretion rates. The significance of individual consistency was the same for both day and night values ($p < 0.01$).

Norepinephrine

NE excretion rates followed a slightly different pattern from those of E and MN.

(1) Intra-individual variation in the excretion rates was less than the inter-individual variation in the day period ($p < 0.05$). This was a different finding from the first year results, where such consistency was not detected.

(2) Individual consistency occurred also for night excretion rates ($p < 0.01$). The same finding was made for the first year data.

(3) The day period means were generally higher than the night period means. There was, however, no apparent tendency for individual with high day period values to rank high in night period values. This agreed with the results of the first year study.

Normetanephrine

NMN excretion rates followed the same pattern as those of NE, except in the levels of significance of individual consistency ($p < 0.01$ during the day; $p < 0.05$ during night). This finding was not made in the first year study.

Vanillyl mandelic acid

VMA excretion rates followed the same pattern as those of E and MN, and the results were in good agreement with the first year study. The only difference being in the levels of significance of individual consistency ($p < 0.05$ during day; $p < 0.01$ during night).

Summary of results

Individual consistency in excretion rates was established for all the catechols both in the day and night periods. As in the first year study, the excretion rates of E, MN and VMA differed from those of NE NMN in the respect that individuals with high daytime excretion levels of E, MN and VMA tended also to have high night-time levels.

Sex differences in excretion rates

The data for the normal group were analysed for sex differences using the Mann-Whitney U test as in the first year sample. As there was only one girl in the autistic group such an analysis could not be made for autists.

No sex differences were found in the night period excretion rates. Two sex differences were found in VMA excretion rates. Girls excreted significantly higher levels of VMA during the day than boys ($p < 0.01$) and also exhibited significantly higher increases from night to day ($p < 0.05$).

Correlation of the excretion rates of the primary amines and their breakdown products

The Spearman rank correlation test was used, as in the first year analysis, to establish whether the excretion rates of E and NE co-varied with those of MN and NMN.

Table 2

Correlation of excretion levels of epinephrine to metanephrine and norepinephrine to normetanephrine (Spearman rank correlation, N = 38)

Hormones	Time of day	r_s	Level of significance
E → MN	day	0.470	$p < 0.01$
	night	0.286	$p < 0.05$
	day / night	0.340	$p < 0.05$
NE → NMN	day	0.240	ns
	night	0.377	$p < 0.05$
	day / night	0.473	$p < 0.01$

The results are presented in Table 2. There was a positive correlation between the excretion rates of E and MN during the day and night and also in the increase from night to day ($p < 0.01$, $p < 0.05$ and $p < 0.05$ respectively). The correlation between the excretion rates of NE and NMN was only apparent during the night and in the increase from night to day ($p < 0.05$ and $p < 0.01$ respectively). These results confirm and widen the correlations between the primary amines and their metabolites found in analysis of the first year results.

III. COMPARISON BETWEEN AND WITHIN THE NORMAL AND AUTISTIC GROUPS

One of the aims of this study was, however, to establish to what degree normal and autistic children differed from each other behaviourally and endocrinologically, and to what extent the autistic syndrome could be considered an extreme form of normal behaviour rather than a distinct phenomenon.

In addition, in view of the differences between the results of the first and second year's work, comparisons were made between the two normal schools and between the two autistic schools. The similarities or differences arising from these comparisons were used to determine whether the groups could be divided into two distinct populations, four distinct populations or a series of overlapping populations.

Endocrine differences between the normal and autistic children

The first year sample

The mean catechol excretion rates for the normal and autistic groups are presented in Fig. 1. They have been incorporated into a diagrammatic representation of the catabolic pathways that degrade catecholamines.

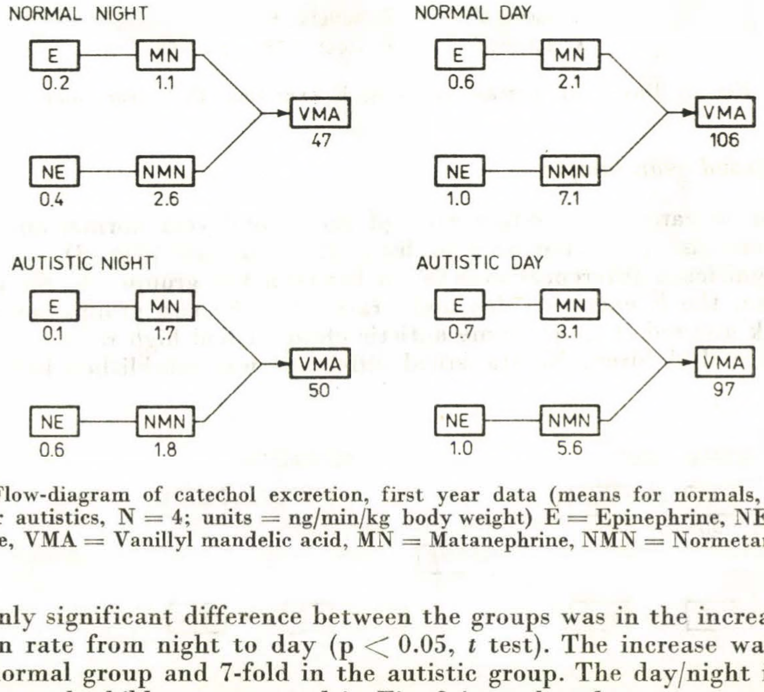


Fig. 1: Flow-diagram of catechol excretion, first year data (means for normals, N = 10; means for autistics, N = 4; units = ng/min/kg body weight) E = Epinephrine, NE = Norepinephrine, VMA = Vanillyl mandelic acid, MN = Matanephrine, NMN = Normetanephrine.

The only significant difference between the groups was in the increase in E excretion rate from night to day ($p < 0.05$, *t* test). The increase was 3-fold in the normal group and 7-fold in the autistic group. The day/night increase ratios for each child are presented in Fig. 2 in rank order.

The night and day period excretion ratios were, however, very similar. Therefore, the difference was further examined with the nonparametric Mann-Whitney U test. This test also showed that the autistic children had higher day/night ratios ($p < 0.05$).

On a number of subsequent occasions both the t test and the Mann-Whitney U test have been applied to the same data. When this has been done it has been to cover the possibility that the behaviour data were not normally distributed around their means. Both tests have also been applied to the equivalent endocrine data to maintain comparability between the two sets of results.

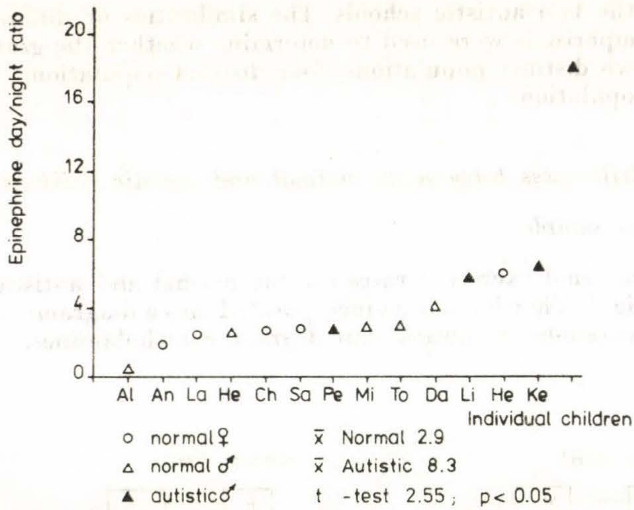


Fig. 2: **Day/night increase ratios in E excretion, first year sample**

The second year sample

The mean catechol excretion rates of the second year normal and autistic groups are also presented as a pathway flow-diagram (Fig. 3).

No significant differences were found between the groups. As for the first year data, the E excretion day/night ratios for the two groups were pooled and rank ordered (Fig. 4). Some autistic children had high ratios, but so did some normal children. No statistical difference was established between the groups.

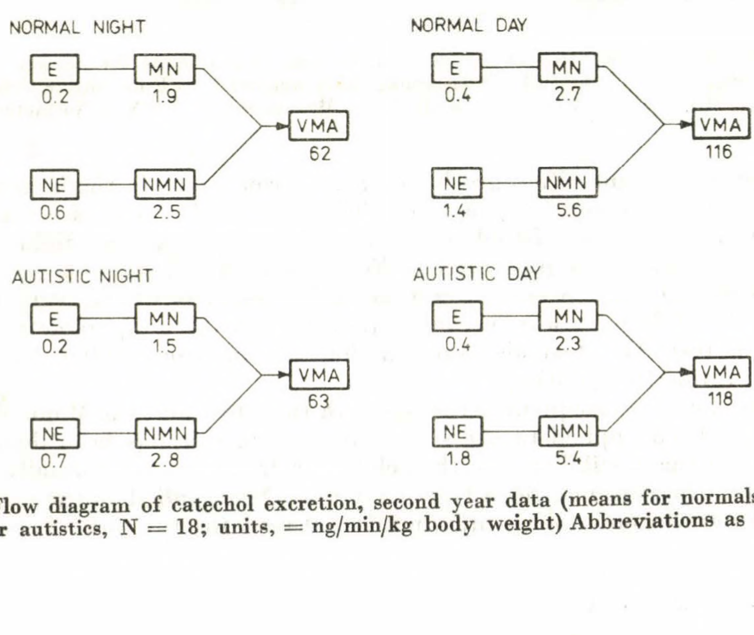


Fig. 3: **Flow diagram of catechol excretion, second year data (means for normals, N = 20; means for autistics, N = 18; units, = ng/min/kg body weight) Abbreviations as in Fig. 1.**

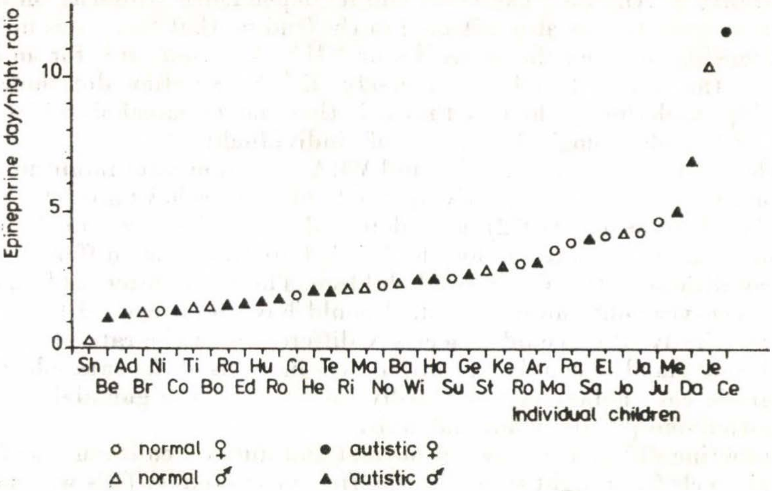


Fig. 4: **Day/night increase ratios in E excretion, second year sample**

In conclusion, one significant endocrine difference was found between the normals and autists in year one: the autists showed greater increases in E excretion from night to day. This difference in E excretion between the autistic children from the two autistic schools or between the normal children from the two normal schools might have caused this discrepancy, but no such differences were detected.

The results suggest that normals and autists do not differ from each other in catecholamine excretion, but present a continuum, so that differences only become apparent if opposite ends of the population spectra are selected.

Summary and Conclusions

Individuals were found to be more consistent in their catechol excretion rates than the groups to which they belonged. This has never been established previously, although PÁTKAI and FRANKENHAUSER (1964) reported week-to-week 'constancy' in catecholamine excretion in individuals. This finding has provided further evidence that individuals have unique endocrine characteristics.

This study showed that under all but one set of conditions (NE ↔ NMN during the day) measuring the breakdown products of catecholamines did not change or contradict the results obtained from the measurement of the primary amines, and that the metabolites' excretion rates co-varied with those of their antecedents, reflecting the original amounts secreted. Thus the use of urinary E and NE levels as indicators of physiological responses to environmental and psychic stimuli is normally justified. The lack of correlation between NE and NMN excretion during the day was probably related to the effects of locomotor activity on the relative rates of excretion of these two catechols.

The lability of NE/NMN excretion and its dependence primarily on the level of muscular activity was also reflected in the finding that there was no consistent relationship between the mean NE or NMN excretion rates for an individual during the day and night. Conversely, E/MN excretion did show such a relationship, underlining the fact that it is these latter catechols which are the most sensitive physiological markers of 'individuality'.

Significant sex differences in MN and VMA excretion were found in the first and second year of study, respectively. Such differences have not been reported previously. JOHANSSON (1972) had detected sex differences in E and NE excretion in a test situation, but had failed to find such differences under normal conditions in twelve-year-old children. The sex differences found in the five to seven-year-old children studied could have been caused by a number of factors. Firstly, they could reflect sex differences in the rate of maturation of the adrenal gland; secondly, sex differences in levels of the catabolic enzymes that degrade catecholamines; or thirdly an effect of the gonadal steroids on the hypothalamo-pituitary-adrenal axis.

An endocrine difference between normal and autistic children was found in E arousal levels from night to day in the first year sample. This was not found in the second year sample. It has been suggested that autistic children are basically timid and, therefore, under constant 'stress' (TINBERGEN and TINBERGEN 1972, RICHER 1976). This might have been reflected in difference in E excretion. However, no differences in catechol excretion between the normal and autistic children seem to exist. It is, therefore, possible, that it is not the absolute levels which differentiate these groups, but their lability in the face of external stimuli.

The results of this study have implied that it is an individual's interpretation rather than the actual stimuli from the environment that will determine the extent of psycho-physiological arousal, and how he or she acts. If the perceived stimuli do not surmount a level of arousal an individual accepts as normal, the system remains constant. If it does, physiological systems respond in given ways by increased or decreased activity beyond the normal range of variation for that individual. A series of behavioural changes accompanies these physiological changes. These changes are functional if they serve to reduce the impact of the perceived environment. This hypothesis gives to behaviour an adaptive role in the relation of environmentally produced physiological upsets.

This hypothesis also helps to explain the finding that whereas autistic children show aberrant behaviour patterns, they are endocrinologically similar to normal children. Some genetic or organic malfunction (FOLSTEIN and RUTTER 1977) in their physiological coping mechanism could give rise to over-arousal in situations that normals handle with comparative ease. Their behaviour might be their way of reducing the impact of the environment.

REFERENCES

ANTON, A. H.—SAYRE, D. F. (1966): Distribution of metanephrine and normetanephrine in various animals and their analysis in diverse biological material. — J. Pharm. Exp. Ther. *153;* 15—29.

BARCHAS, J.—CIARANELLO, R.—STOLK, J.—BRODIE, H.—HAMBURG, D. (1972): Biogenic amines and behaviour. — *In:* LEVINE, S. (Ed.): *Hormones and Behaviour*, pp. 235—319. — Academic Press, New York.

CARRUTHERS, M.—TAGGART, P.—CONWAY, N.—BATES, D.—SOMMERVILLE, W. (1970): Validity of plasma-catecholamine estimations. — Lancet, *2;* 62—67.
FOLSTEIN, S.—RUTTER, M. (1977): Genetic influences and infantile autism. — Nature, *265;* 726—728.
FRANKENHAUSER, M. (1971): Experimental approaches to the study of human behaviour as related to neuroendocrine functions. — *In:* LEVI, L. (Ed.): *Society, Stress and Disease.* Vol. I. pp. 22—35. Oxford University Press, New York.
JOHANSSON, G. ;(1972): Sex differences in the catecholamine output of children. — Acta physiol. Scand. *85;* 569—572.
McCULLOUGH, H. (1968): Semi-automated method for the differential determination of plasma catecholamines. — J. Clin. Path. *21;* 759—763.
NAGATSU, T. (1973): *Biochemistry of Catecholamines.* — University of Tokyo Press, Tokyo.
PÁTKAI, P.—FRANKENHAUSER, M. (1964): Constancy of urinary catecholamine excretion. — Percept. Mot. Skills, *19;* 789—790.
PISANO, J. J.—CROUT, J. R.—ABRAHAM, D. (1962): Detection of 3-methoxy-4-hydroxy mandelic acid in urine. — Clin. chim. Acta, *7;* 285—291.
RICHER, J. (1976): The social avoidance behaviour of autistic children. — Anim. Behav. *24;* 898—906.
TINBERGEN, E. A.—TINBERGEN, N. (1972): Early childhood autism — an ethological approach. — *Advances in Ethology*. Suppl. 10, J. Comp. Ethology, 1—53. Verlag Paul Parey, Berlin and Hamburg.

Author's address: Dr. HILKKA HELEVUO
Biological Laboratory, University of Kent at Canterbury
Canterbury CT2 7NJ
Kent
England

[illegible], M., [illegible], B., [illegible], H., [illegible], W. (19[illegible]): Viability ... [illegible] ... estimations. ... [illegible] 62–65.

[illegible] (19[illegible]) ... [illegible] ... 122–125.

[illegible] (19[illegible]): ... [illegible] ... University Press, New York.

[illegible] (197[illegible]): ... [illegible] ... 569–577.

[illegible], H. (1966): ... method for the ... [illegible] ... 759–765.

[illegible] (1978): ... [illegible]

[illegible], M. ... [illegible] ... Skolh. [illegible]

[illegible] ... [illegible]

[illegible] (197[illegible]): ... [illegible] ... Acta, Scien. [illegible] 859–91[illegible].

[illegible] ... [illegible] ... in Ethology ... [illegible] ... Verlag, [illegible] ... and Heidelberg.

Author's address: Dr. [illegible]
Biological Laboratory, University of Kent at Canterbury
Canterbury CT2 7NJ
Kent
England

Anthrop. Közl. *24;* 119—122. 1980.

EXAMINATION OF PHYSICAL DEVELOPMENT OF DOWN'S PATIENTS IN VIEW OF THREE BODY MEASUREMENTS — A FOLLOW-UP STUDY

by L. HORVÁTH and J. BUDAY

(Laboratory of Human Genetics, Maternity Care Centre, Budapest, Hungary; Department of Pathophysiology, Training College for Teachers of Handicapped Children, Budapest, Hungary)

Abstract. This paper is a report on the growth of three body measurements (height, weight and head circumference) of 80 Down's patients, 49 boys and 31 girls relying on a longitudinal study. Two examinations of body measurements of boys and girls from Budapest were used as controls. The said three parameters of the newborn Down's patients were lower than the ones of the controls. The rhythm of growth was somewhat slower and, therefore, the difference was accentuated with age. The curve of z values of body weight was the same as that of the normal children, but the Down's patient's values were greater than 0 in both sexes at all ages.

Key words: growth and development, Down's patients, body measurements.

The examination of the body development of persons with aneuploidy is one of the most important possibilities to study the genetics of growth. Authors were interested in the development of children with Down's syndrome, the latter being the only human autosomal aneuploidy where the examinations are performable. Only a few publications deal with the body development as a longitudinal study of Down patients (ROCHE 1965, RARICK and SEEFELDT 1974, CRONK 1978).

This paper presents the examinations of 80 children with Down's syndrome (49 boys and 31 girls). From time to time these children were examined by physicians and at the same time their body measurements (height, weight and head circumference) were taken. Authors also knew their measurements as birth. The youngest child was one month, the oldest was 28 years old. The distribution of the number and time of these observations were rather irregular within this interval. Authors compared their results with two examinations conducted in Budapest. One of these covers the data of children aged from 0 to 5 years, the other presents the data of children aged between 6 and 18 years.

Figure 1 shows the growth of the body height and its age deviation in children aged between 0—18 years. The results confirm that hyposomy belongs to the obligatory symptoms of Down's syndrome.

In Figure 2 the average weight and its age deviation can be seen. The body weight of the children with Down's syndrome is lower than that of the control. The backwardness is increasing during life, but is less considerable than body height and generally does not surpass the value of 1—1.5 SD. The data of these two figures are in accordance with the experience gained of the specific

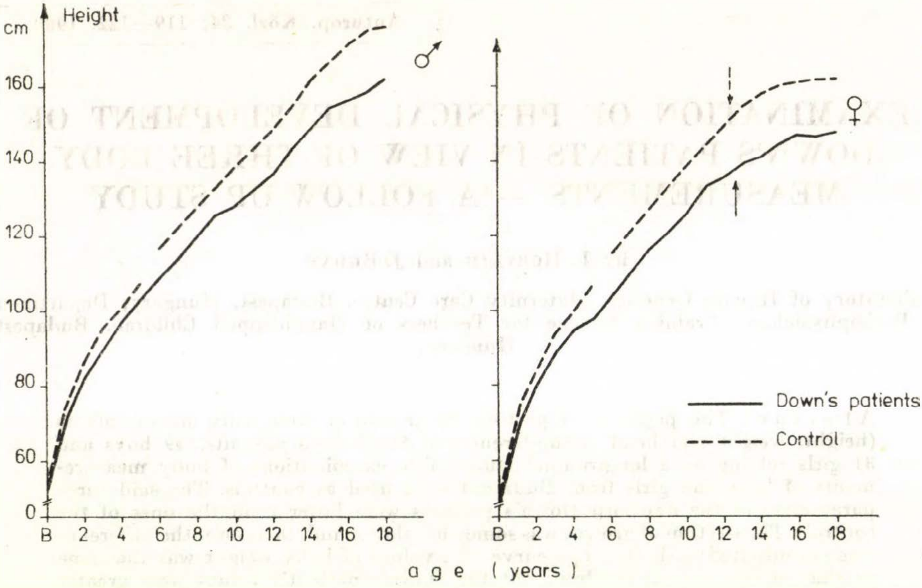


Fig. 1: **Growth and age deviation of the body height**

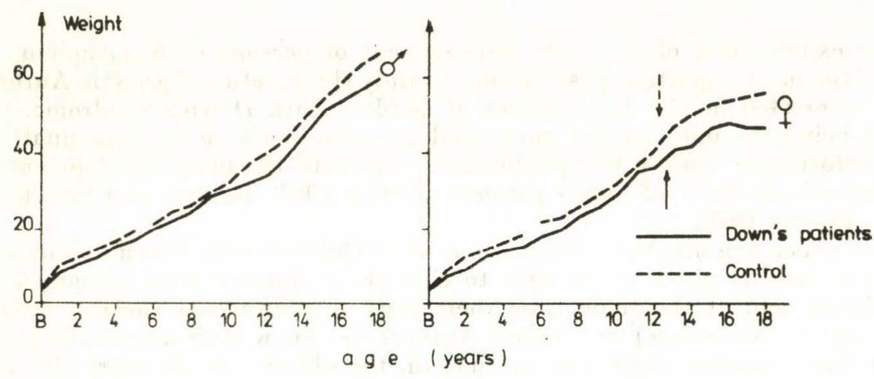


Fig. 2: **Growth and age deviation of the body weight**

physique of Down's patients. Nevertheless, it is a most important fact that the fatness of Down's patients is not a consequence of their higher body weight, but depends on the considerable backwardness in body height.

This is supported by the fact, that the Kaup's index of the patients is generally higher than that of the control (Fig. 3).

The means of the head circumference and the age deviations confirm the observation that also microcephaly belongs to the obligatory symptoms of Down's syndrome (Fig. 4).

The above data on the relations of body height and weight are concordant with the fact thas the proportionality profile of patients differs from the

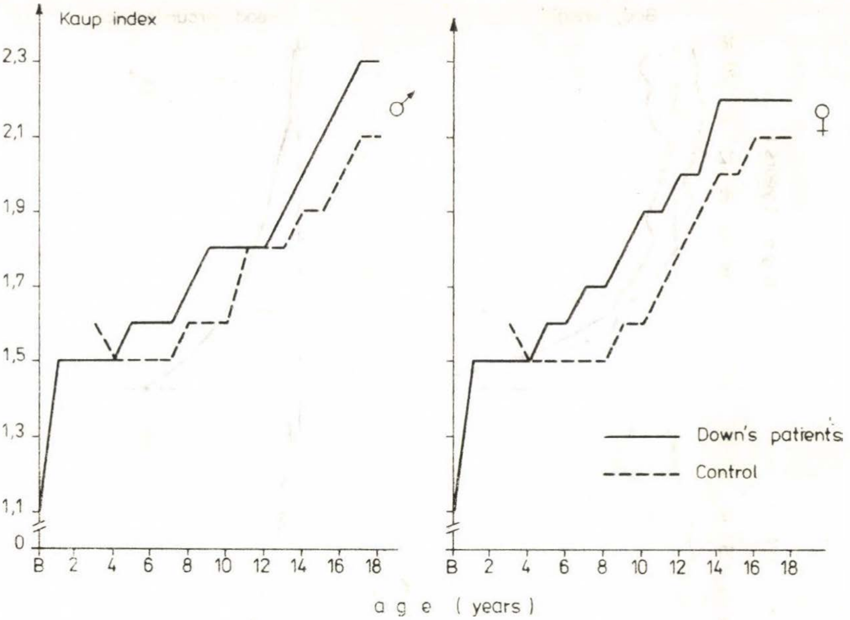


Fig. 3: **Kaup index**

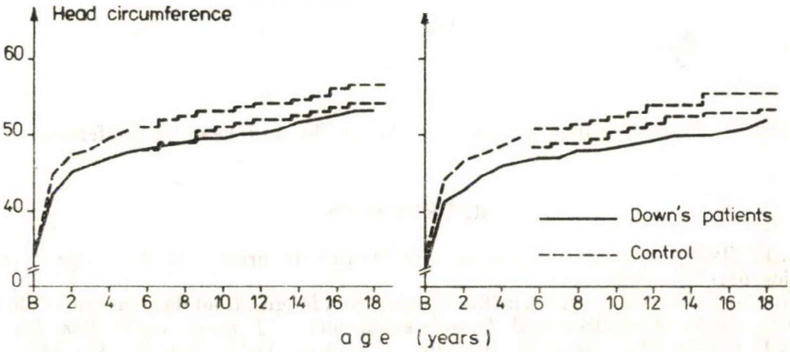


Fig. 4: **Growth and age deviation of the head circumference**

control, and that the z values are positive without exception. The z values of the head circumference are also higher than 0 (Fig. 5).

Finally, authors have to speak about the age at menarche. They noted it according to the parents' remembrances. It followed as demonstrated by the authors at 12.61 ± 0.91 years of age. They could get date directly from 12 girls only. Yet, it has to mention that this average does in all probability not correspond with reality. In four girls the menarcheal age is considerable low (about 11 years) in the others it is higher (about 13 years). Further examinations will decide whether this age is only accidental or not. Maybe there are great differences in the age at menarche of the girls with Down's syndrome.

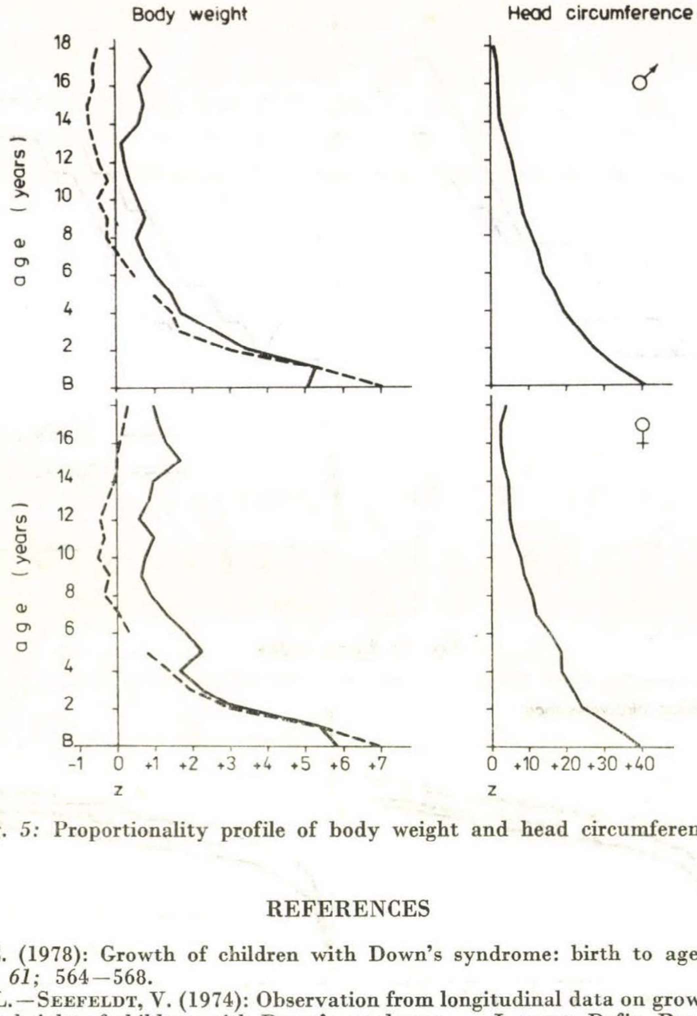


Fig. 5: Proportionality profile of body weight and head circumference

REFERENCES

CRONK, C. E. (1978): Growth of children with Down's syndrome: birth to age 3 years. — Pediatrics *61;* 564—568.

RARICK, G. L.—SEEFELDT, V. (1974): Observation from longitudinal data on growth in stature and sitting height of children with Down's syndrome. — J. ment. Defic. Res. *18;* 63—78.

ROCHE, A. F. (1965): The stature of mongols. — J. ment. Defic. Res. *9;* 131—145.

Authors' addresses: Dr. HORVÁTH LÁSZLÓ
Lab. Human Genetics, Maternity Care Centre Schöpf-Merei Hospital
H-1092 Budapest, Knézich u. 14.
Hungary

Dr. BUDAY JÓZSEF
Training College for Teachers of Handicapped Children
H-1071 Budapest, Bethlen tér 2.
Hungary

Anthrop. Közl. *24;* 123–136. 1980.

PHYSIQUE AND PERFORMANCE

by E. Jokl

(University of Kentucky, Lexington, U.S.A.)

Abstract. The author analyses the theme against the background of the world wide improvement of all athletic records during our century, showing the extent to which performance growth relates to varieties of the athletes' physiques. Detailed evidence pertaining to the issue has been derived from studies of weight-lifters since in the discipline under reference different body weight classes as well as different techniques of application of muscle power offer themselves for investigation. The fact that body bulk is not an advantage in contests such as those requiring powers of endurance allows insight into the categorical difference between kinetic and dynamic modalities of specific activity displays. Concerning the biological background of the overall performance explosion in sport during the preceding decades, the author will enumerate the underlying social, nutritional, medical and epidemiological advancements that have rendered the phenomenon under review possible. Special attention will be paid to exclusive human characteristics of motor capacities, as against performance elements that involve physiological mechanisms ubiquitously present in the animal world.

Key words: physique, performance, strength, endurance, athletes, weight lifting, effects of training, genetic endowments, adaptive responses, cardiac adaptation.

Varieties of physiques

Performance growth in some sports — not in all — relates to a variety of the athletes' physiques. The determining role of bodybuild is recognized in wrestling and weight lifting in which separate competitions are held in 9 — since 1976 in 10 — body weight classes. In Figure 1 winning performances in the Annual Weight-lifting World Championships are plotted for the years 1948 to 1972, for the bantam, light-and super-heavy-weight classes (46 kg, 67.5 kg, and 110 kg and above). In the first two, a trend of the curves to flatten out is noticeable; in the third until recently a continuous rise due to the appearance on the athletic scene of extraordinarily heavy contestants. The two greatest super-heavy-weights of the last decade *Zhabotinsyi* and *Alexyev* both Olympic Champions weighed over 160 kg. However, save in exceptional circumstances like those just mentioned, eccentric body weight is of no advantage in sport. The American super-heavy-weight wrestler *Chris Taylor*, who weighed 440 pounds, competed at the 1972 Olympic Games in Munich. In one of the greatest athletic performances of all times, the German wrestling champion, *Wilfried Dietrich* whose weight was almost 200 pounds less, threw *Taylor* and pinned him.

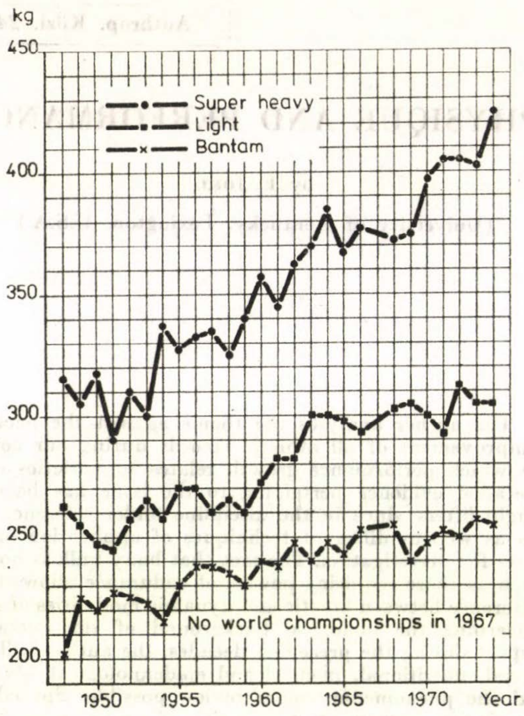


***Fig. 1:* Winning performances in the annual Weight-lifting World Championships between 1948 and 1972 in three weight classes**

Weight-lifting

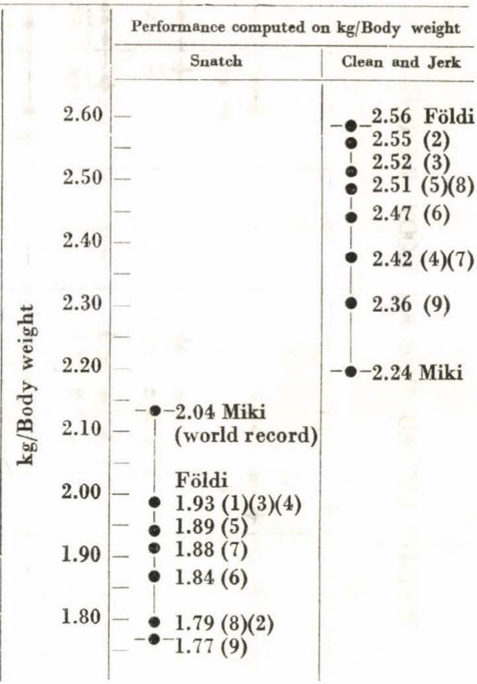
Most weight lifters lift greater weights with the 'clean and jerk' than with the 'snatch). The reason is that in the 'clean and jerk' the extension power of the legs can be brought to bear upon the performance twice; with the 'snatch' the weight must be lifted in one upward movement which precludes the double support action of the lower extremities. Asian weight-lifters as a group are relatively strong in the 'snatch' and relatively weak in the 'clean and jerk', an observation which points to their great arm strength which also explains in part the conspicuous excellence of Japanese gymnasts. The above explanation of the performance differences in the two weight-lifts is of special interest for students of biomechanics of sport, e.g., for an analysis of the techniques of the ski jump and of the shot put (Table 1).

I have calculated the winning performances per kg body weight for all weight classes at the Olympic Games in Mexico City in 1968, at the world championships in Lima, Peru in 1971, and at the Olympic Games in Munich in 1972: The relative strength of super-heavy-weight champions was much less than that of the contestants in the lighter body weight classes (Fig. 2). One of the reasons for the relative power superiority of the lighter weight class weight lifters is that they are not fat. Because the fat content of the female body is proportionately greater than that of men, women generally do not equal men's perform-

Table 1

Bantam class weight-lifting
(52.6—56.0 kg body weight; Olympic Games Munich, 1972)

Placement	Name and country	Body weight	Total kg	Total LBS
(1)	**Földi** Hungary	55.70	377.5	832.25
(2)	**Nassiri** Iran	55.90	370	815.75
(3)	**Chetin** Russia	55.65	367.5	810.25
(4)	**Trebicki** Poland	55.70	365	804.5
(5)	**Kirov** Bulgaria	55.70	362.5	799.25
(6)	**Vasiliades** Australia	55.60	355	782.75
(7)	**Ono** Japan	55.85	355	782.75
(8)	**Todorov** Bulgaria	55.80	350	771.75
(9)	**McKenzie** England	55.20	342.5	754.75
(1)	**Miki** Japan	55.80	342.5	754.75



Some weight-lifters who perform oustandingly in the snatch are unable to do likewise in the clean and jerk. Insofar as the final placement of competitors is determined by the total score attained with both lifts,* the above mentioned discrepancy was not always realized. An example is illustrated in figure 3b showing the numerical sequence of the 10 best participants in the final placement of the weight-lifting contest at the 1972 Olympic Games in the bantam weight class (52.6 = 56.0 kg). Miki (Japan) who ranked 10th topped the list for the snatch in which he established a new world record (114.0 kg). Per kg/bw he lifted 2.04 kg as against the Gold-Medalist's (Földi, Hungary) 1.93 kg. The latter, however, attained an equivalent of 2.56 kg/bw in the clean and jerk, while Miki's kg/bw equivalent for the clean and jerk was only 2.24.

Most Asian weight-lifters do relatively better in the snatch than in the clean and jerk. The validity of this statement is borne out by observations of competitors from Japan, Korea, Taiwan, Burma and other Far Eastern countries. This phenomenon is of interest also for the clarification of the problem of the "ethnological endowment spectrum for athletic performences" in general.

ances in athletic contests demanding strength. The difference in physical power between men and women is least marked if one compares performances of athletes of light physique, e.g., of weight-lifters of the fly weight-class (52 kg). Here men as well as women athletes entering contests are invariably lean.

Mrs. *Meridy Warden Schmidt* of Seattle was the first woman to win an open State Championship in weight-lifting against male opponents.

Physique, strength and endurance

The relative size of the heart of the world's best women middle distance runners is almost twice as great as that of the champion discus throwers. The inequality of the physiques of *Olga Korbut* and *Alexyev*, both Olympic Champions is evident. *Alexyev* won gold medals in weight-lifting, *Korbut* in gymnastics. The term fitness in as far as it relates to athletic physique is meaningless — unless it is used in reference to a specifically identified performance category.

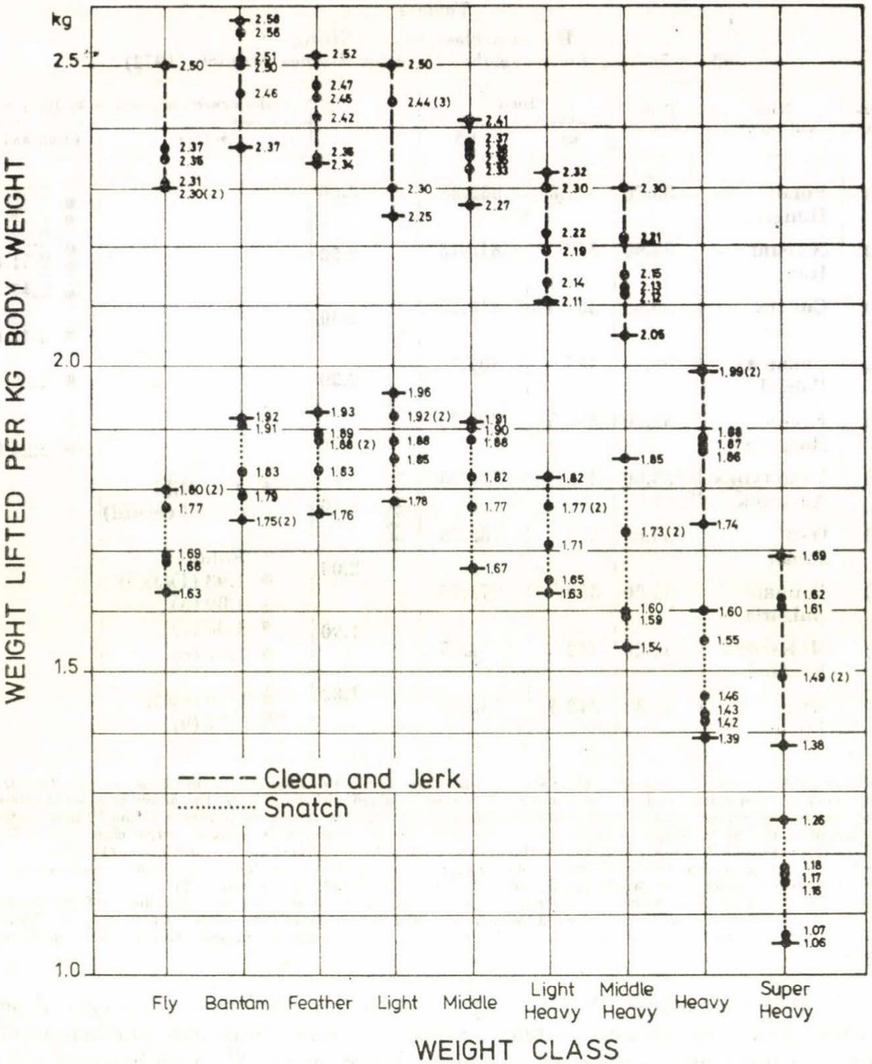


Fig. 2: **Weight lifted per kg body weight by six best performers in nine weight-classes with clean and jerk and with snatch (the 25th World Weight-lifting Championships, 15–26 September 1971, Lima, Peru)**

Height and weight of champion athletes

During the past decades marked increases have been noted in height and weight of the world's best competitors in many — again not all — sports. Figure 3 shows measurements obtained from the finalists in the throwing and long-distance events at the Olympic Games in Amsterdam in 1928, in Rome in 1960, in Tokyo in 1964 and in Montreal in 1976. Champion athletes today

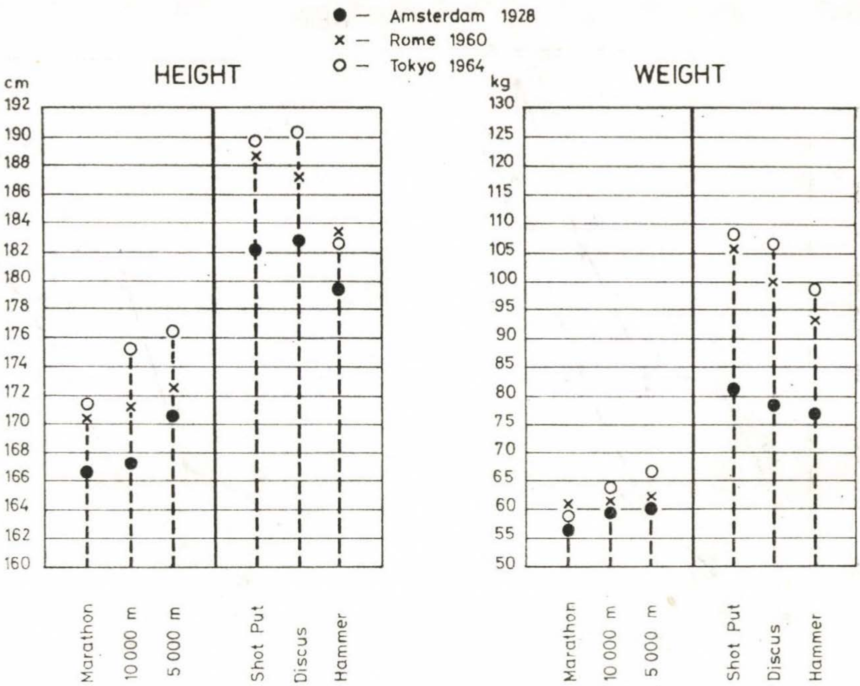


Fig. 3: Height and weight of Olympic athletes have consistently gone up during the past decades. At the 1928 Olympic Games, finalists in running and throwing events were smaller and weighed less than they do now. Differences are greatest for the throwers who today are far heavier and stronger than they were 50 years ago

are taller and heavier than they were 50 years ago, most notably so in the case of the throwers.

Figure 4 compares height, weight and body index of the University of Kentucky basketball teams of 1948 and 1968. The 1948 players who won the NCAA Championship as well as the Olympic Games tournament in London wer much smaller and weighed less than the players in 1968. The "team structure" in as far as it is represented by the body measurements of the five starters has remained the same in 1948 and 1968. Good basketball teams include but one or two very tall players; the other 3 need not be of exceptional height, even though it is true that midgets are not especially suited for the sport.

Major improvements of skill have taken place continuously during the past 30 years as the evaluation of play statistics shows. Free throw percentages for the starters increased from 63.08% for the 1948 University of Kentucky Champions, to 77.85% for their successors in 1968; field goal percentages from 33.47% in 1948 to 55.97% in 1968. Play technique will go on improving in the next decade; while further changes in physiques are not likely to occur.

Champion basketball players are chosen during their high school years on

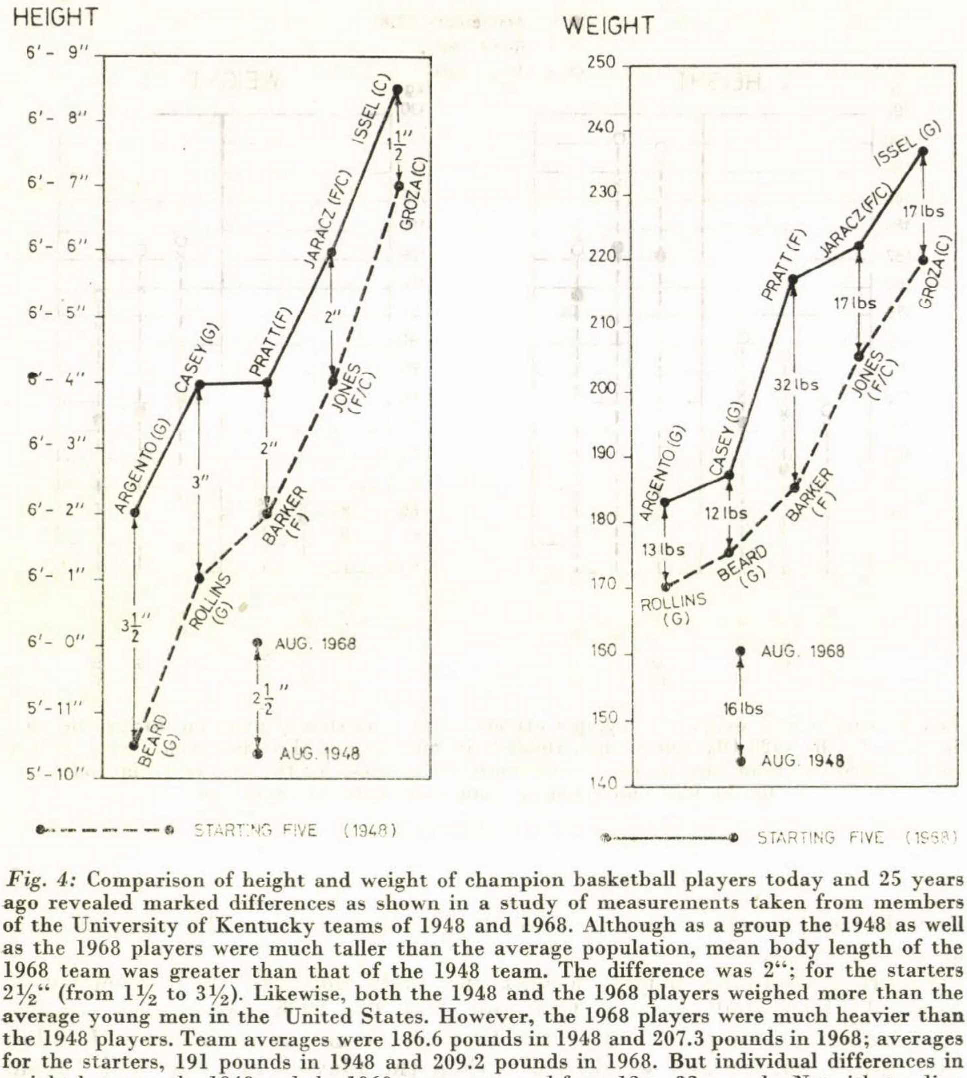


Fig. 4: Comparison of height and weight of champion basketball players today and 25 years ago revealed marked differences as shown in a study of measurements taken from members of the University of Kentucky teams of 1948 and 1968. Although as a group the 1948 as well as the 1968 players were much taller than the average population, mean body length of the 1968 team was greater than that of the 1948 team. The difference was 2"; for the starters $2\frac{1}{2}$" (from $1\frac{1}{2}$ to $3\frac{1}{2}$). Likewise, both the 1948 and the 1968 players weighed more than the average young men in the United States. However, the 1968 players were much heavier than the 1948 players. Team averages were 186.6 pounds in 1948 and 207.3 pounds in 1968; averages for the starters, 191 pounds in 1948 and 209.2 pounds in 1968. But individual differences in weight between the 1948 and the 1968 starters ranged from 12 to 32 pounds. Notwithstanding these differences in height and weight, the overall physical "design" of the two teams' physiques was similarly patterned: The "diagonal" arrangement of the graph presentation of sizes and weights of the five starters in 1948 and 1968 illustrates the point. The fact that a good team does not consist of equally tall and heavy players was well established in 1948.

the basis of their endowment — morphological and otherwise. Tall basketball players are not tall because they play basketball; they are attracted early in their lives to basketball because their tallness renders them suitable for the game. Sustained training is of course the other prerequisite for success in basketball so as it is a prerequisite for success in all other sports.

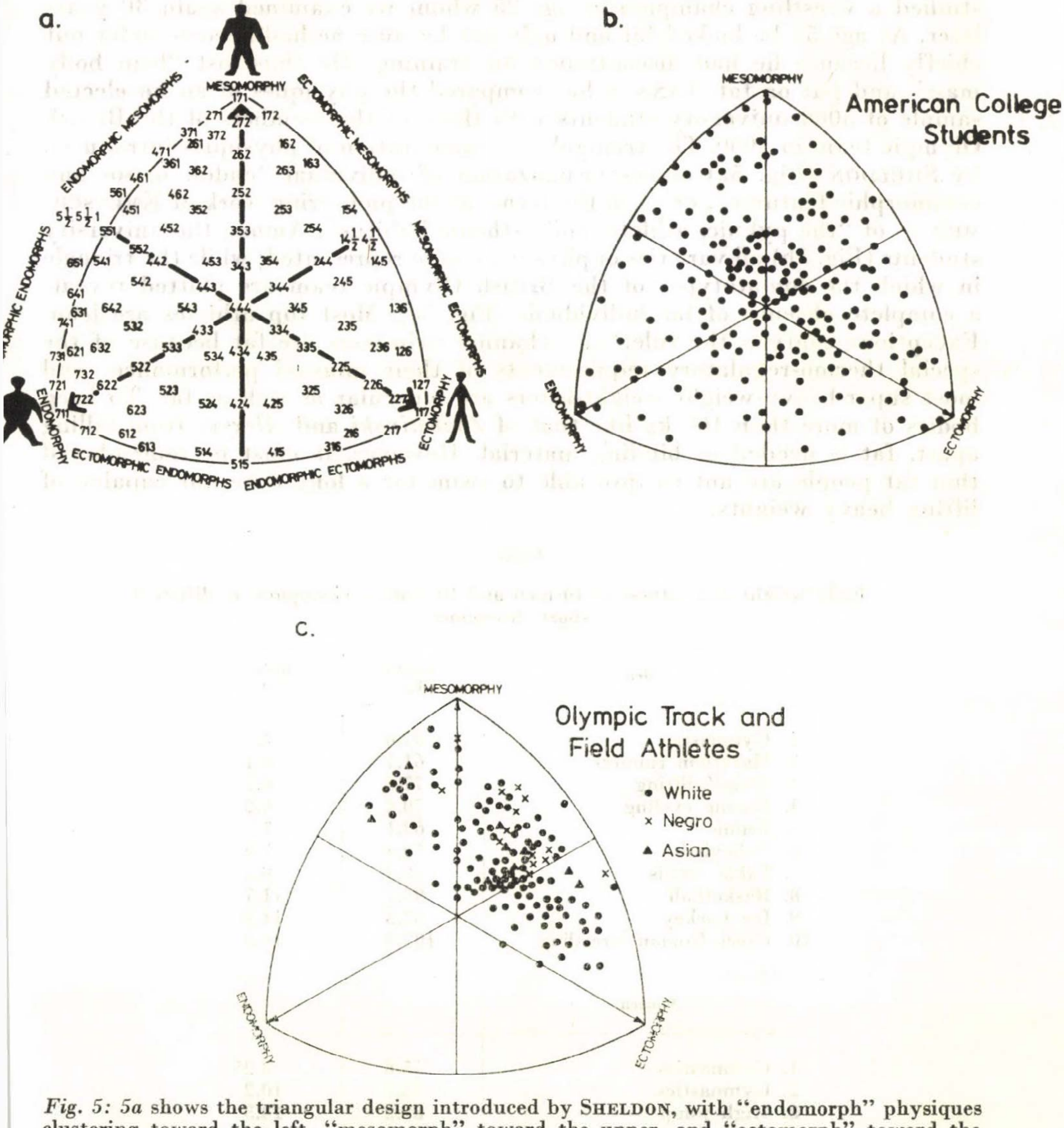


Fig. 5: 5a shows the triangular design introduced by SHELDON, with "endomorph" physiques clustering toward the left, "mesomorph" toward the upper, and "ectomorph" toward the right apex The results of Sheldon's survey of somatotype distribution of 4000 male American college students in 1940 are shown in *5b*. Each dot represents 20 students. The concentric clustering around the 444 central crossing of the three hypotenuses of the triangle of the majority of the points, and the decreasing density of representation toward the three apices is evident. *5c* shows the distribution of the somatotypes of the members of the British track and field team for the 1960 Olympic Games in Rome. Comparison between triangles *b* and *c* reveals the absence among the athletes of fat individuals.

Effects of training

Intensive training causes major changes of body composition. We have studied a wrestling champion at age 25 whom we examined again 30 years later. At age 55 he looked fat and ugly not because he had become older but chiefly because he had discontinued his training. He thus lost "lean body mass" and put on fat. TANNER has compared the physiques of an unselected sample of 5000 university students with those of the members of the British Olympic team in 1960. The triangular documentation of physiques introduced by SHELDON (Fig. 5a) allows visualization of individual "endo-, meso- and ectomorphic features", or — in the terms of the pioneering work of KRETSCHMER — of "the pyknic, athletic and asthenic habitus". Among the university students (Fig. 5b) all varieties of physiques were represented; while the triangle in which the somatotypes of the British Olympic team are plotted reveals a complete absence of fat individuals (Fig. 5c). Most top athletes are lean. Exceptions confirm the rule: e.g., channel swimmers are fat because of the special thermo-regulatory requirements of their unusual performance; and most super-heavy-weight weight-lifters are muscular as well as fat. To keep bodies of more than 160 kg like that of *Zhabotinski* and *Alexyev* from falling apart, fat is needed as binding material. However, it must be remembered that fat people are not eo ipso able to swim for a long time nor capable of lifting heavy weights.

Table 2

Body weight and fatness of 10 men and 10 women champions in different sport disciplines

Men	Weight (kg)	Body Fat
1. Gymnastics	67.6	4.5
2. Marathon runners	61.7	6.1
3. Weight-lifting	77.6	6.2
4. Racing cycling	70.8	6.2
5. Tennis	63.1	7.3
6. Volleyball	79.4	7.9
7. Table tennis	58.5	9.2
8. Basketball	98.1	11.7
9. Ice hockey	67.3	14.8
10. Greco-Roman wrestling	103.2	19.0
Women		
1. Gymnastics	55.6	8.25
2. Gymnastics	53.5	10.2
3. High jump	62.2	10.3
4. 10 m diving	50.0	12.4
5. Skiing 10 km	54.6	13.5
6. Swimming	69.8	13.8
7. Ice skating	58.3	15.3
8. Tennis	62.5	18.2
9. Table tennis	52.4	18.3
10. Shot put and discus	81.7	19.7

In a classical study on Channel swimmers who had made it from Dover to Calais in 16 hours, PUGH and EDHOLM found that their subjects were conspicuously obese. For them, they wrote, "it is good to be fat".

In 1954 I reported that among 261 participants in a Marathon race in Philadelphia 12 were distinctly fat, a surprising finding. They finished the race in poor times (between 5 and 7 hours) — but they finished. Since then hundreds of fat men and women have run the Marathon, an observation of considerable physiological and clinical relevance.

Of interest are results of a study conducted by NOVOTNÝ and PAŘÍZKOVA who assessed the fat content of the bodies of 10 men and 10 women athletes who had attained championship honors in the competitive disciplines enumerated in Table 2. The unexpectedly large range of proportional values of lean body mass and fat in this group calls for special interpretation.

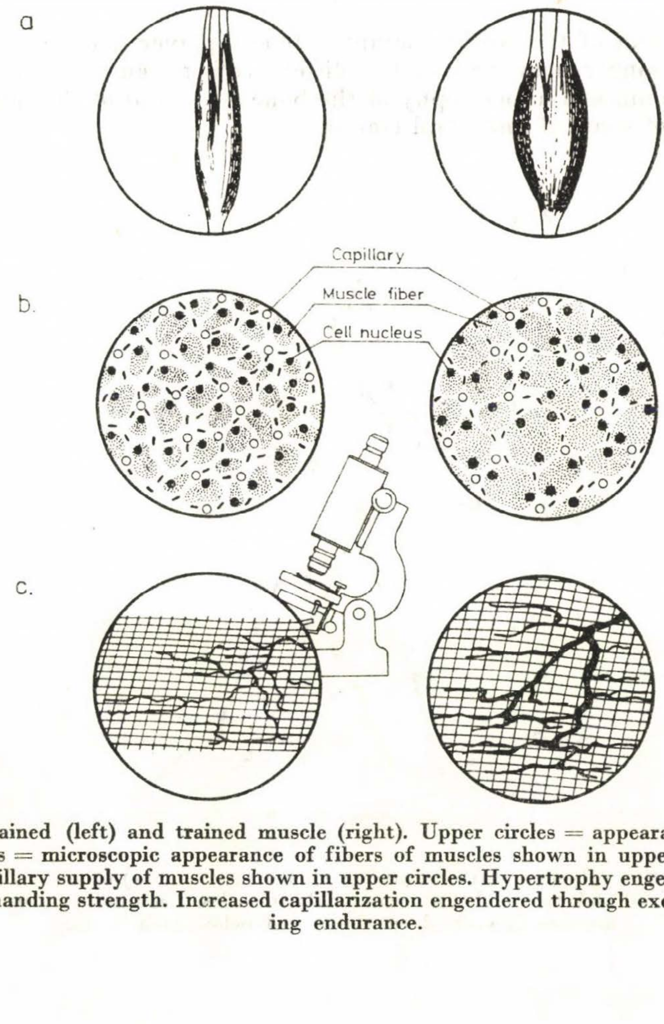


Fig. 6: Untrained (left) and trained muscle (right). Upper circles = appearance of muscle; middle circles = microscopic appearance of fibers of muscles shown in upper circles; lower circles = capillary supply of muscles shown in upper circles. Hypertrophy engendered through exercises demanding strength. Increased capillarization engendered through exercises demanding endurance.

Genetic endowment and adaptive responses

As is being pointed out elsewhere in this book, a categorical distinction must be made between genetically endowed design of physiques, and adaptive bodily changes due to training. The tallness of basketball players to which reference has been made before exemplifies the determining role played by the former; the status of the skeletal musculature of world champion body builder *Arnold Schwarzenegger* that of the latter.

Figure 6 shows that muscular hypertrophy brought about by power training is due to increases in size of individual fibers; while greater density of the capillary net is engendered by endurance training. Another anatomical prerequisite for performances of power and of endurance is the proportional representation of light and dark fibers. The former are 'fast twitching', the latter 'slow twitching'; the former develop considerable kinetic force for a short time; the latter sustain contraction power of lesser intensity for extended periods. Only the latter are surrounded by a ring of capillaries. Both the fast and slow twitching fibers increase equally in size when the muscle hypertrophies (Fig. 7).

The right arm of the world champion tennis player (shown in Fig. 8a) is bigger and stronger than the left. The difference between the two extremities, including the marked hypertrophy of the bones (Fig. 8b) of the right forearm, is the result of years of unilateral training.

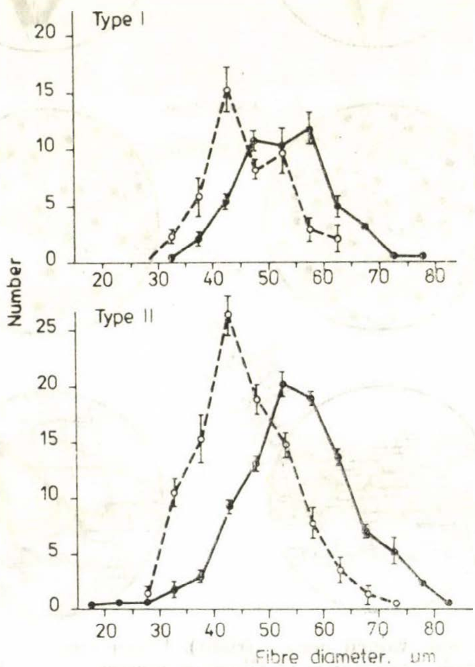


Fig. 7: Distribution polygons of fibre diameter for the type I (slow) fibres and type II (fast) fibres in control (0) and exercised (0) biceps brachii muscles. Each point is the mean of five muscles. SEs are given above and below each mean.

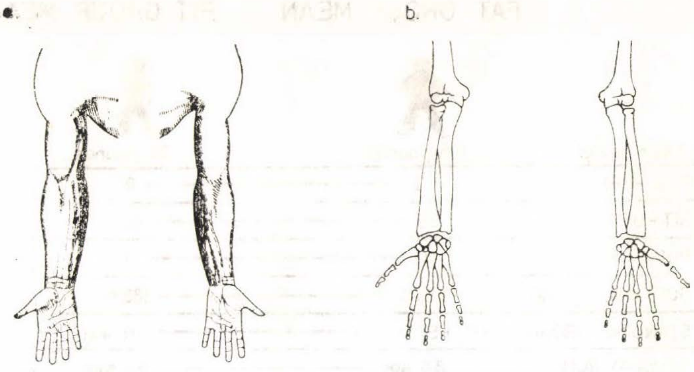


Fig. 8: 8a. **Right and left arms of professional tennis player. Note generalized hypertrophy as well as venous dilation of right arm.** ***8b:*** **Drawings made from X-rays of both arms of world champion tennis player. Note osseous hypertrophy of right arm**

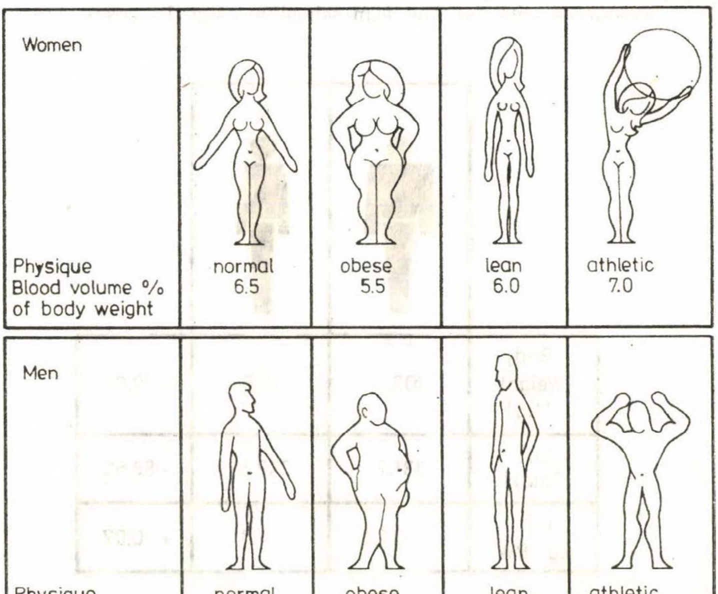


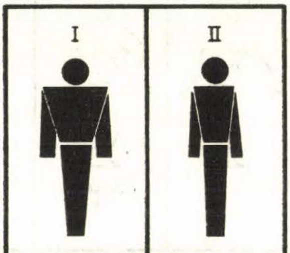
Fig. 9: **Blood volume of athletes is greater than of non-athletes. It is smallest in fat persons.**

Another adaptive response to training is the hypertrophy of the liver which accompanies the enlargement of the heart and of the adrenal glands, most markedly brought about by activities demanding physical endurance. Also the body of trained athletes contains more water than that of untrained people (Fig. 9). Fat tissue contains virtually no blood vessels. The extent to which fitness and fatness are related is shown in Figure 10 which tabulates results

FAT GROUP MEAN FIT GROUP MEAN

Mean weight	156 pounds	125 pounds
PULL-UPS	3	9
SIT-UPS	36	82
PUSH UP	14	47
SOFTBALL THROW	125 ft.	188 ft.
STANDING BROAD JUMP	5 ft. 1 in.	6 ft. 4 in.
50 YARD RUN	8.6 sec.	6.4 sec.
SHUTTLE RUN	10.8 sec.	9.4 sec.
600 YARD RUN	2 min. 44 sec.	1 min. 59 sec.

Fig. 10: **Comparison between results of U.S. President's Council of Youth Fitness test conducted with fat and lean schoolboys age 13 years**



	I	II	
Body Weight (kg)	102.5	73.5	- 29.00
Lift (Total)	331.1	242.6	- 88.50
Lift kg/BW	3.23	3.3	+ 0.07

Fig. 11: **Heavy weight weight-lifting champion turned Marathon runner (see the text)**

of physical performances tests for the 10 fattest and the 10 fittest boys, aged 13, selected from a class of 50. The fat are not fit and the fit are not fat.

Even extreme obesity can be drastically reduced through exercise. JEAN MAYER conducted studies on hereditary obese-hyperglycemic mice in whom the bulk of the extra calories came from inactivity and not from hyperphagia. Their weight gain could be prevented by treadmill exercise, also by breeding into the strain the "waltzing gene" which caused them to be in constant rotary movement. Their weight gain was less than one tenth that of the control

litter. Also hypothalamic obesity in the mouse is due to an extraordinary degree of inactivity.

The magnitude of the body's adjustibility to training in its different forms is shown by the following observation.

A 25-year-old heavy weight champion in weight lifting, at the time of his best performances, weighed 102.5 kg. The total of his two best lifts amounted to 331.1 kg, equivalent to 3.23 kg per kg body weight. At that time he decided to discontinue with his weight lifting career and took up long-distance running. Within 3 years he lost 29.0 kg body weight, was able to run the 26 mile marathon in 3 hours. His best combined lift was now 242.6 kg, i.e., 88.5 kg less than his former best. However, in terms of power computed per kg body weight he was slightly stronger (+0.7 kg) (Fig. 11).

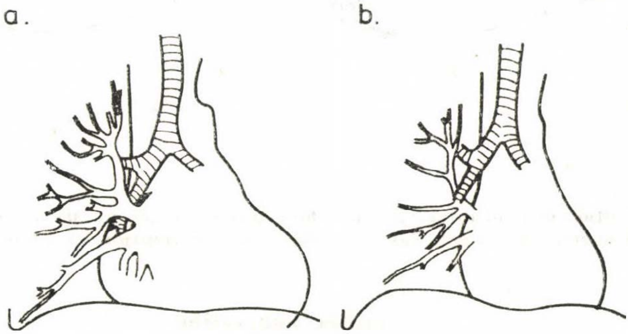


Fig. 12: **Outlines of hearts of two 26-year old men of identical weight and height, drawn from tomographic plates. Left: heart of a world champion cyclist; right: heart of untrained subject**

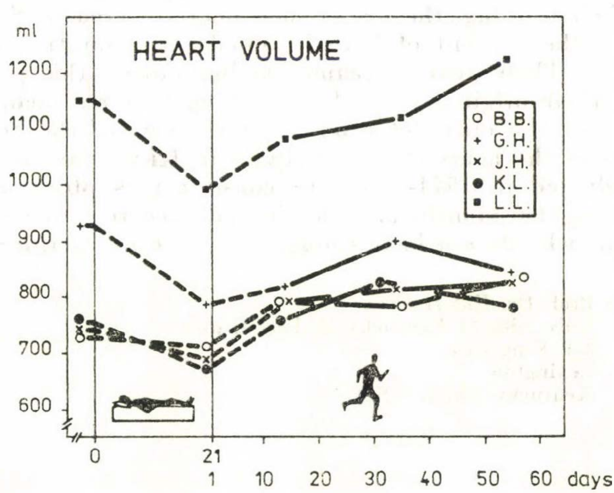


Fig. 13: **Prolonged bed rest leads to a noticeable reduction in the size of the heart. Changes in heart volume with bed rest and training. Individual data before and after bed rest and at different intervals during training (after B. Saltin)**

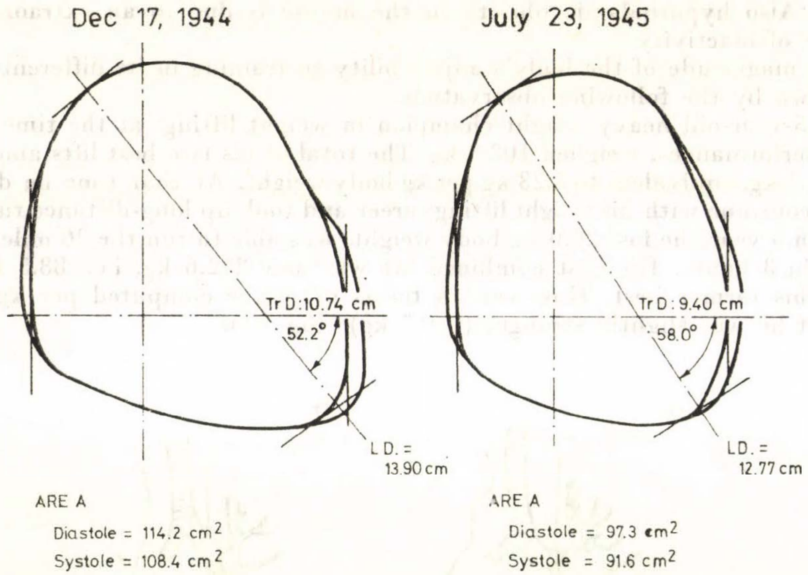


Fig. 14: **Limitation of food intake below 1500 calories per day causes a decrease in the size of the heart. The effect was reversible with resumption of a normal diet.**

Cardiac adaptation

Good long distance runners, long distance cyclists, long distance skiers, and long distance swimmers have large hearts; while untrained and fat people have what RAAB called "loafers' hearts" (Fig. 12). If good endurance athletes discontinue their training, the size of their hearts decreases. SALTIN in Stockholm obtained the consent of 5 well-trained cross-country runners to stay 21 days in bed. Their hearts became smaller during this period (Fig. 13), and regained their original size when training was resumed.

Training is not the only determinant of the size of the heart. Figure 14 shows outlines of the heart of a participant in KEYS' famous starvation experiment conducted in 1944—45 with conscientious objectors; on the left before, on the right 6 months after having adhered to a diet of 1500 calories per day. People who do not have enough to eat do not perform well in sport.

Author's address: **Prof. Dr. ERNST JOKL**
University of Kentucky Medical Center
340 Kingsway
Lexington
Kentucky 40502 U.S.A.

Anthrop. Közl. *24;* 137–151. 1980.

AGING IN THE PAST. BIOCHEMICAL ASPECTS OF SKELETAL AGING IN RECENT AS WELL AS IN ARCHAEOLOGICAL PERIODS

by I. A. LENGYEL

(Central Laboratory of the Polyclinic, Budapest XVIII., Hungary)

Abstract. Skeletal aging is a main projection of the developmental processes of the organism: of a synchronized succession of biochemical and morphological events. The molecular biological essence of skeletal aging can be followed by quantitative and qualitative changes occurring in the chemical composition of the bone tissue. On the basis of these changes the time bounderies of several developmental phases can be designated.

— How can the organism's development from these chemical changes in recent and in past populations be explored?

— How can the time boundaries of the consecutive developmental phases in these populations be compared?

— How can the time-lags be explored and evaluated?

The aim of the author's paper is to present plausible answers to these questions.

Key words: paleobiochemistry, biochemical changes, archaeological series, bones, phosphorus, carbonate, calcium, collagen, cristal water, skeletal aging.

Introduction: The problem

In the biological past of man there was a period, the history of which can be learned primarily from skeletal remains. When examining archaeological bones we want to puzzle out the aging processes as a biological feature of our ancestors by a complex method which, against the practice of historical anthropology, bases its system of gathering information not on the morphological peculiarities of the skeletal remains but on their chemical composition and on the changes in their structure.

The main and more or less imperative reason of introducing a new chemico-analytical procedure arises from the great number of sources of errors which may upset the reliability of the morphological method.

Touching upon some of the inevitable difficulties, which the anthropologists have to face, author refers to the following facts:

In childhood (Inf. I. + Inf. II. + Juv.) the primary age indicators are:

— the eruption of deciduous and permanent teeth (GUSTAFSON 1950, OLIVIER 1960, BALOGH 1964);

— the union of the epi- and diaphyses of the long tubular bones (TODD 1924, STEWART 1957, FLECKER 1942, PYLE and HOERR 1955, GREULICH and PYLE 1959, JOHNSTON and SNOW 1961); and

— the formation of the basilar bone of the skull (MARTIN and SALLER 1957, VALLOIS 1960).

Considerable sex differences can be found in the time of the eruption of the deciduous and permanent teeth, and in the time of the fusion between the epi- and diaphyses of the long bones (Moyers 1959, Todd 1924, Johnston and Snow 1961) as well. The determination of the individuals' sex, however, can be carried out only after the accomplishment of the secondary sex characters of the skeleton, thus it is hardly possible to draw reliable conclusions before the end of the juvenile life period.

There are further minor differences in the order and chronology of tooth eruption and of the closure of the epiphyseal lines in the various main races (Genovés 1960), but the skulls of children are not suitable for taxonomical examinations (Martin and Saller 1957).

There are several pathologic processes to which may delay the development of these age indicators (Howells 1960, 1966, Jarcho 1966).

Last, but not least, as a consequence of present-day general acceleration the time of dentition, as well as of the union of the epi- and diaphyses of the long bones has changed, probably it takes place earlier as compared with the historical periods (McKern 1957, Stewart 1957, Acsádi and Nemeskéri 1970). But who knows how much earlier?

If besides all these one considers that the morphologic method requires, within the bounds of possibility, whole skeletons (Demish and Wartmann 1956), just another question mark has to be put after its results, either concerning the biological reconstruction of the aging processes, or the estimation of the palaeodemographic parameters of earlier populations.

Author's methods used

Since a few fragments of ancient bones suffice for examinations carried out with author's chemico-analytical method, it yields reliable results even if the skeletal remains are scanty or poorly preserved. Applied to the skeletal remains of a whole graveyard, one may gain information not only about the age at death of each separate individual but by the help of appropriate statistical computations also about the dynamism of the aging processes of the population fragment opened up.

Relying on the evidence of the biochemical literature one knows that with advancing age certain quantitative and qualitative changes can be observed in the chemical composition of the bone tissue (Mitchell et al. 1945, Lengyel 1976a).

1. With the advance of age the total phosphorus content diminishes (Fourman 1960, Winand and Dallemange 1962); while,

2. in a contrary direction the proportion of calcium carbonate changes, namely increases, within the total quantity of calcium (Van Slyke and Sendroy 1927, Shear and Kramer 1928, Brown 1966, Pellegrino, Biltz 1968).

3. The absolute calcium content grows up to a certain phase of the endocranial closure of the coronal and sagittal sutures, then it remains on an unchanged level up to the beginning of senile age, thereafter, it decreases parallel to the old age athrophy of the skeleton (Hansard et al. 1954, Termin 1966, Lengyel 1968, Höhling 1969).

4. The quantity of collagen increases until the growth of the skeleton is concluded and afterwards, it begins to drop at an ever growing rate (ROGERS et al. 1952, MILLER and MARTIN 1968).

5. These changes are partly caused and partly followed by the growth of the hydroxyapatite microcrystals impregnating the matrix and the collagen fibres; further by the thinning down of their hydratation shell. In other words: by the fall in the water content and, consequently, by the slowing-down rate of ionic exchange in the bone tissue (ROBINSON et al. 1955, NEUMAN and NEUMAN 1958, KAY et al. 1964, ZAMBOTTI and BOLOGNANI 1976).

Looking for interrelations among the data of the biochemical literature, of the anamnensis and chemical composition of the bone tissue of the individuals, author constructed his recent standard series of fresh, roughly 1000 dissecting-room cases, in which he knew the various calendar ages, so that he also knew that in the medical case history of none of them could pathologic processes be found, liable to influence the chemical composition of the bones. Which means that each individual of author's standard series was "healthy" in respect of his/her skeleton (LENGYEL 1976b).

The quantities presented by the five chemical age symptoms were determined from the spongy substance of the lumbar vertebral bodies. Then the

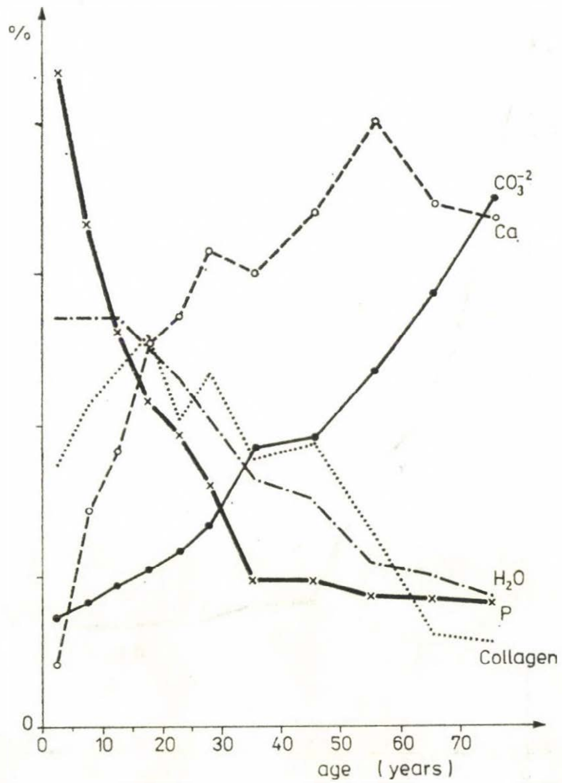


Fig. 1: **A respective graph demonstrating the changes of the chemical composition of the bone tissue in author's recent, standard series**

author arranged the results in a line according to the age progression of the individual members of his recent series next he divided them into age groups. In each age group he calculated several parameters: mean, variance, correlation, regression, etc. (MATHER 1960, HOLMAN 1962).

Results and Discussion

On the basis of the changes in the mean values, having taken place as a result of aging, a respective graph was plotted (Fig. 1).

What one can see in this picture at the first sight, is a network of tangled lines running up and down, but after a closer look at them we can recognise that the direction of the curves is in accordance with the general views reported before.

1. The quantity of *phosphorus* consistently diminishes from birth to the highest age. The first significant break of its slope between 16 and 20 years indicates the end of the puberal changes. The next one is between 21 and 25 years referring to the completion of skeletal growth. The most pronounced change in its slope is between 31 and 40 years of age. From there the curve

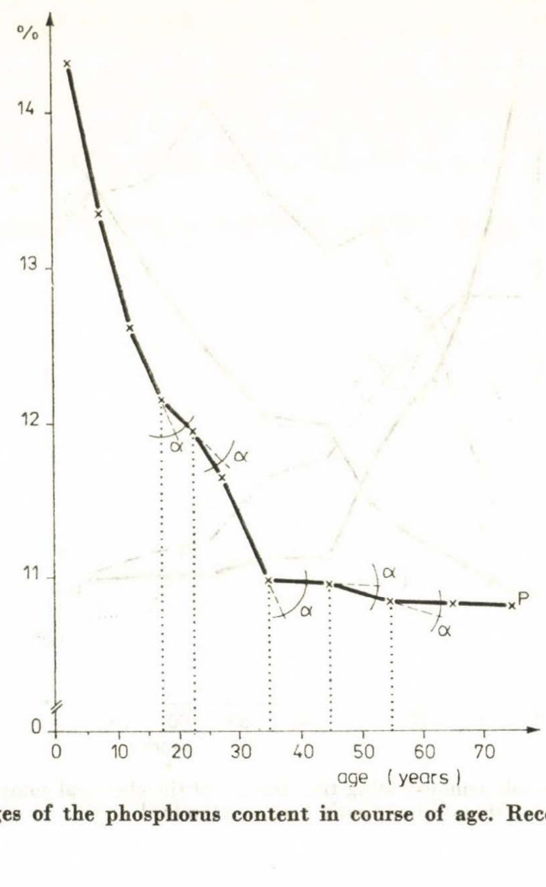


Fig. 2: Changes of the phosphorus content in course of age. Recent standard series

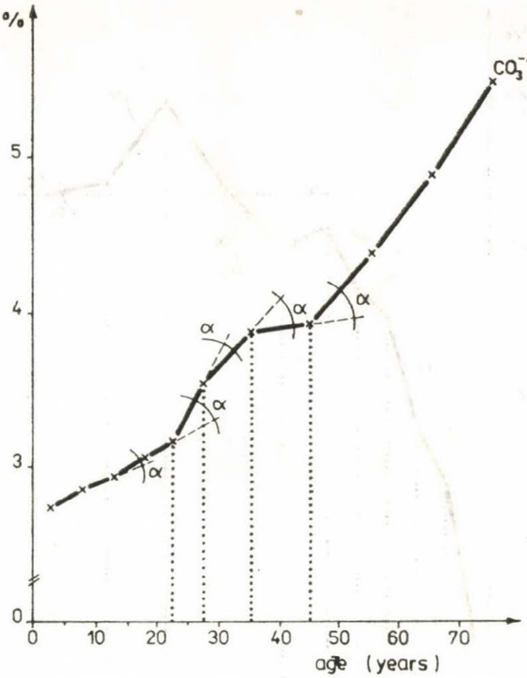


Fig. 3: Changes of the carbonate content in course of age. Recent standard series

runs horizontally towards its last change (between the 51 and 60 years). The horizontal portion indicates the biologically stable period of adulthood, while its last declining phase represents the beginning of senile atrophy (Fig. 2).

2. The *carbonate* content of the bone tissue increases in a monotonic sequence from birth to the highest age. Its first break between 21 and 25 years of age, coincides with the second one of the phosphorus curve. The second break in its slope follows between the 26th and 30th years, the biological meaning of which is not quite clear. The last two breaks can be found at the same ages as with the phosphorus curve, and they refer to the beginning and to the accomplishment of the biologically stable period of our life (Fig. 3).

3. The direction of the *calcium* curve changes from a rising tendency at the beginning, through a relatively stagnant period into a declining one at the end. Its first break between 6th and 10th years of age probably means a change in the developmental rate of the infantile organism. The next break falls between 11th and 15th years, at the beginning of the puberal period, while the subsequent one between the 16 and 20 years, indicates the end of that period. The first peak of the calcium curve chronologically coincides with the second break of the phosphorus- and the first break of the carbonate curve, together they refer to the completion of skeletal growth. The first peak of the calcium curve is followed by a fall. The explanation is that the results of the examination conducted in males and females are represented together in the same graph and, in case of females, in the reproductive period of their life; the effects of pregnancies and lactations are reflected by a temporary diminution of the

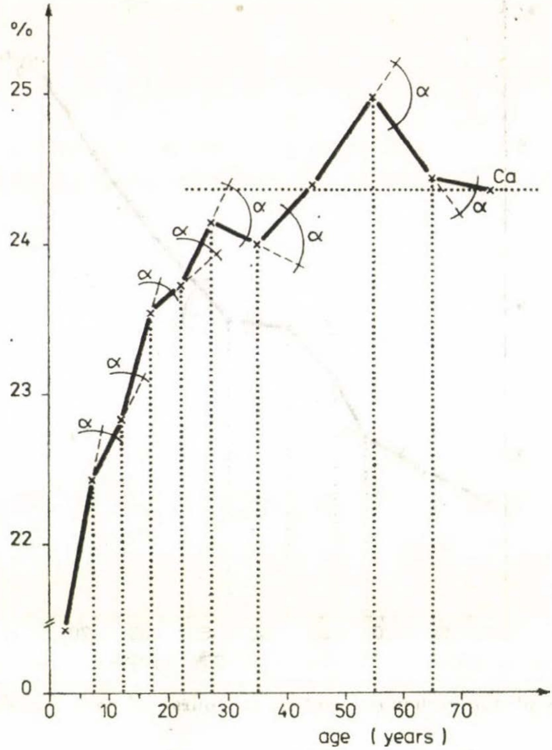


Fig. 4: **Changes of the calcium content in course of age. Recent standard series**

calcium content. The second peak of the calcium curve is in accordance with the last break of the phosphorus curve. Probably it refers to a higher degree of calcification of the bone tissue before the beginning of senile atrophy. The second peak is followed again by a fall, producing the last break of the slope between 61 and 70 years. The regular succession of peaks and falls may sustain the physiological origin of this phenomenon, however its proper explanation is still required. The last declination is certainly a consequence of the senile atrophy of the skeleton (Fig. 4).

4. The *collagen* content shows an irregular fluctuation caused by different physiological, pathological and nutritional effects. What is obvious: after an initial rise its curve shows an irregular fluctuation followed by gradual diminuation, without any further peaks (Fig. 5).

5. The quantity of the chemically bound and crystal water shows a stepwise decrease from birth to the highest age. Generally, the slopes of the water curve correspond in time to those of the phosphorus and carbonate curves (Fig. 6).

As shown by the experience gained from our recent standard series, the changes in the phosphorus and carbonate content are classified as the primary chemical age symptoms of the skeleton. The basis of this classification is their monotonic sequence, the narrower range of their standard deviation, and their greater efficiency in the practice of age estimation.

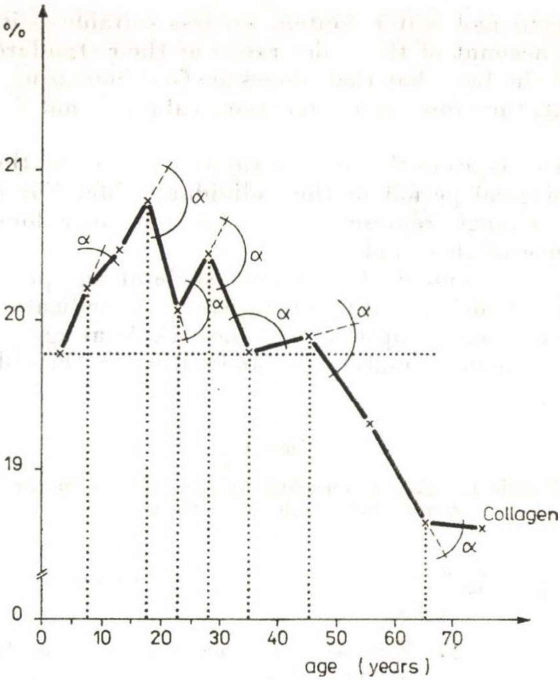


Fig. 5: **Changes of the collagen content in course of age. Recent standard series**

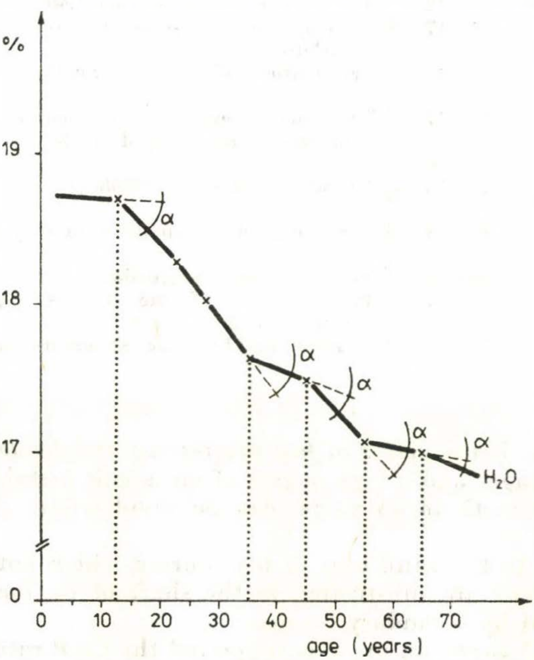


Fig. 6: **Changes of the water content in course of age. Recent standard series**

Calcium, collagen and water content are less suitable as indices of skeletal aging; partly on account of the wider range of their standard deviation, and partly in view of the fact that their slopes are first increasing, then decreasing with age and that, therefore, their regression values do not lie along a straight line.

The significant changes in the slope of these curves mean the first symptoms of a new physiological period in the individuals' life. For safety's sake we suppose that only changes represented by a break of their slope over 10 degrees have a significance of this kind.

Drawing the lines among the various skeletal age periods, the author accepts only those as being well founded, which are indicated by at least two of the five chemical age symptoms. The new skeletal age-periods developed on the results of our chemico-analytical examinations are the following (Table 1).

Table 1

Periods of skeletal aging as reflected by the changes in the chemical composition of the bone tissue

Periods	Subunits	Calendar age	Comments
I.		0—23	Period of fast progression and development; metabolic instability
	1.	0— 3	The woven bone is substitued by a lamellar one in the shaft of long bones
	2.	4—12	The Ca/P ratio shifts from 1.40 to 1.70
	3.	13—17	Development of secondary sexual character of the skeleton
	4.	18—23	Termination of skeletal growth
II.	—	24—27	Transitional period, development has ceased, metabolic processes are rendered stable
III.	—	28—45	Period of biological stability
IV.	—	46—55	Symptoms of metabolic instability appear again
V.		56— x	Period of senile regression
	1.	56—70	Polymorphism of the osteons appears again. Ca/P ratio = 2.25
	2.	71—x	Characterized by senile osteoporosis and skeletal atrophy

(1) The first one is the *period of fast progression and development*, characterized by rapid changes and a high degree of metabolic instability. This period, which lasts from birth to 23 years, can be divided into four chronological subperiods:

a) From birth to the third year of life: during which both the woven and the primary osteons are substituted in the shaft of the long bones by lamellar structures and by secondary osteons;

b) From 4 to 13 years: during this subperiod the Ca/P ratio shifts from 1.40 to 1.70;

c) From 13 to 17 years: this is the time of the development of secondary sexual characters of the skeleton;

d) From 18 to 23 years: the period of the termination of skeletal growth, which can be read off from the parallel changes in the phosphorus-, carbonate- and calcium slopes.

(2) The second period is a *transitional* one, during which the development stops and the metabolic processes are rendered stable. This period lasts from 24 to 27 years of age.

(3) The third period is that of *biological stability* and includes the time between 28 and 45 years of age.

(4) During the fourth period between the 46 and 55 years the symptoms of *metabolic instability* appear again, and eventually.

(5) The fifth period which can again be divided into two subperiods:

a) the first of these is characterized by a histochemical, that is *metachromatic polymorphism of the osteons* and by a slight *senile regression* of the skeletal tissue; it lasts from the 56th to 70th years of age;

b) the second subperiod is dominated by the symptoms of *senile osteoporosis* and expressed *skeletal atrophy*. It starts at about 70th years of age and continues to the highest age.

So that the biological age at death of earlier populations could be determined, the chemical composition of roughly 8000 human skeletal remains were examined. They could be divided into series according to their historical age, and within the single series into samples according to the cemeteries from which they had been brought to light (Table 2).

Table 2

The age at death has been determined by the author's chemico-analytical method in the series as follows

Series	Inf. I. + II. + Juv. %	Ad. + Mat. + Sen. %	Together
1. Recent, standard	45	55	965
2. XVth—XIXth centuries A.D.	53	47	915
3. Xth—XIVth centuries A. D.	41	59	1692
4. VIth—IXth centuries A.D.	43	57	1651
5. IIIth—Vth centuries A.D.	48	52	1082
Sum total	—	—	6305

In case of these series, the facts that the factors of decomposition are practically uniform, if anatomically identical bones are involved, which dating from the same chronological period, and had been interred in the same kind of soil and excavated from the same depth, the author is justified to interpret changes in the chemical composition of archaeological bones according to the same principles as those observed in fresh autopsy material.

One may come to know that among the members of the same sample the highest phosphorus value indicates the individual who died at his youngest age, and the lowest one who died at the oldest age. — The carbonate content changes just the other way round: the lowest values indicate the youngest individual, while the highest ones the oldest. Founded on these considerations we arrange the examination results gained the same sample, i.e. the same cemetery in a line according to the decrease in phosphorus- and the increase in carbonate content. This order of succession corresponds, atleast theoretically, to the age scale of those buried in the examined cemetery.

Then, with the help of a mathematical equation the age as death of the individuals can be calculated. Let us term the threshold concentration values of the chemical age symptoms in the age groups:

t_1 = for 0—3 years,
t_2 = for 4—12 years,
t_3 = for 13—17 years, and so on.

Then let us take the following function, where the index $_k$ refers to the age group in question (Fig. 7).

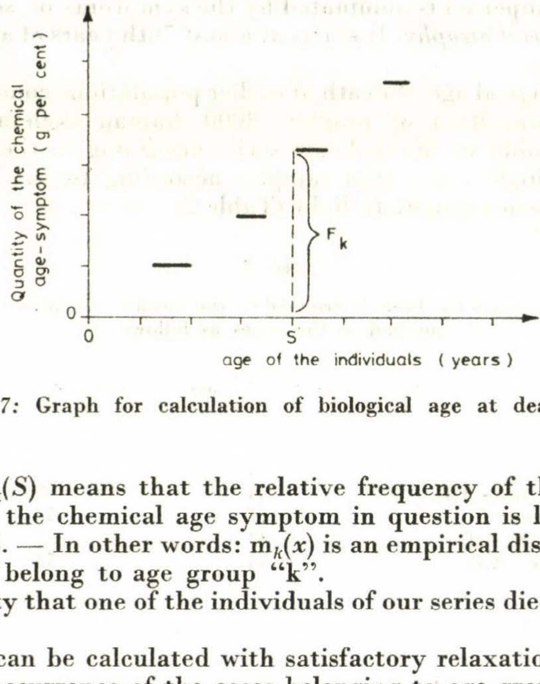


Fig. 7: Graph for calculation of biological age at death

The figure $F_k(S)$ means that the relative frequency of the cases in which the quantity of the chemical age symptom in question is less than or equal to the value of S. — In other words: $m_k(x)$ is an empirical distribution function of cases, which belong to age group "k".

The probability that one of the individuals of our series died in the age group "i", is p_i.

The p_i value can be calculated with satisfactory relaxation, if we calculate the percentual occurrence of the cases belonging to age group "i" among the individual of the series examined.

Let us suppose that in a concrete case, the quantity of the examined chemical age symptoms lies between the values *a* and *b*. In such a case, according to BAYES's proposition, the likelihood that the age of the late individual is within the range of age group "k", is:

$$\frac{[F_k(b) - F_k(a)] \cdot p_k}{\sum_{i=1}^{9} [F_i(b) - F_i(a)] \cdot p_i}$$

Designating the above-mentioned probability with $q_{1k}, q_{2k}, q_{3k} \ldots q_{9k}$, concerning the single age groups, index "k" is equal to the age group sought for, if $(q_{1k}) \cdot (q_{2k}) \ldots (q_{9k})$ gives the highest possible value while its probability is equal to the appropriate product of this multiplication.

When comparing the results of our chemical examination to those achieved by the morphological method, we make use of the χ^2 test. The two methods indicate the same age as the highest percentage (83%) with males in the period of biological stability. The females of the same period, however, show smaller agreement (66%). A life cycle of this kind lies in the middle of the age scale and if we move away from it either upwards (to the senium), or downwards (to infancy), maybe just on account of the expansion of the individual differences between biological and calendar ages, and because the variances show a wider dispersion, there can be found an ever growing discrepancy between the result of the two methods. — However, when comparing their results in general, there are no significant differences between them in either historical period. On the contrary, greater variations in the degree of the agreement can be observed depending on the anthropologist who carried out the morphological examinations (Fig. 8).

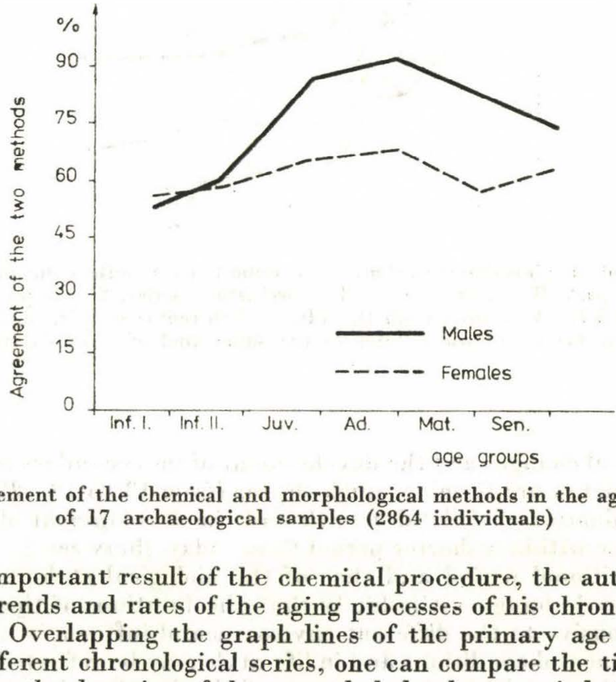


Fig. 8: The agreement of the chemical and morphological methods in the age-groups in case of 17 archaeological samples (2864 individuals)

As a more important result of the chemical procedure, the author is able to compare the trends and rates of the aging processes of his chronological series or cemeteries. Overlapping the graph lines of the primary age symptoms in case of the different chronological series, one can compare the time of beginning, as well as the duration of the several skeletal age periods (Figs 9, 10).

Going backwards in the chronological past, the following phenomena can be observed:

1. The duration of the first chronological subperiod generally takes a longer time (from birth to 4—5 years);

2. however, the chemical changes characteristic of the second subperiod require equal lengths of time in each series (5—12 years).

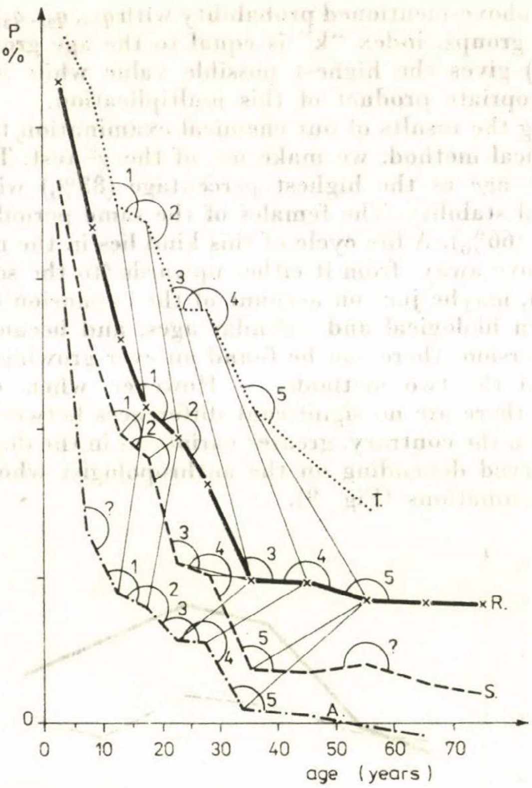


Fig. 9: **Changes of the phosphorus content of the bone tissue as reflect the differences in aging processes in the past. R = recent series, T = prehistoric series, S = series from the Xth—XIVth centuries A.D., A = series from the VIth—IXth centuries A.D.; 1, 2, 3, etc. changes of the various slopes which refer to the same kind of physiological events**

3. The puberal changes and the development of the secondary sexual charact-ters of the skeleton are forming much slower (from 13 to 19—20 yeras).

4. The dermination of skeletal growth and the development of the organism run their course within a shorter period than today (between 21 and 23 years).

5. The transitional period and that of the biological stability undergo the most pronounced changes: it is likely that the durations of these two periods are most responsive to the different environmental influences. Any alteration in the environmental conditions and in life style may be reflected by the length of these periods; and because — in case of the female subpopulation — the two periods together are more or less identical with the period of fertility, their shortening may have a serious influence on the number of the offspring in the following generation.

6. The fragment of the earlier populations which was able to live to a senile age brings about the same chemical and histochemical changes during the same period of time as our recent population.

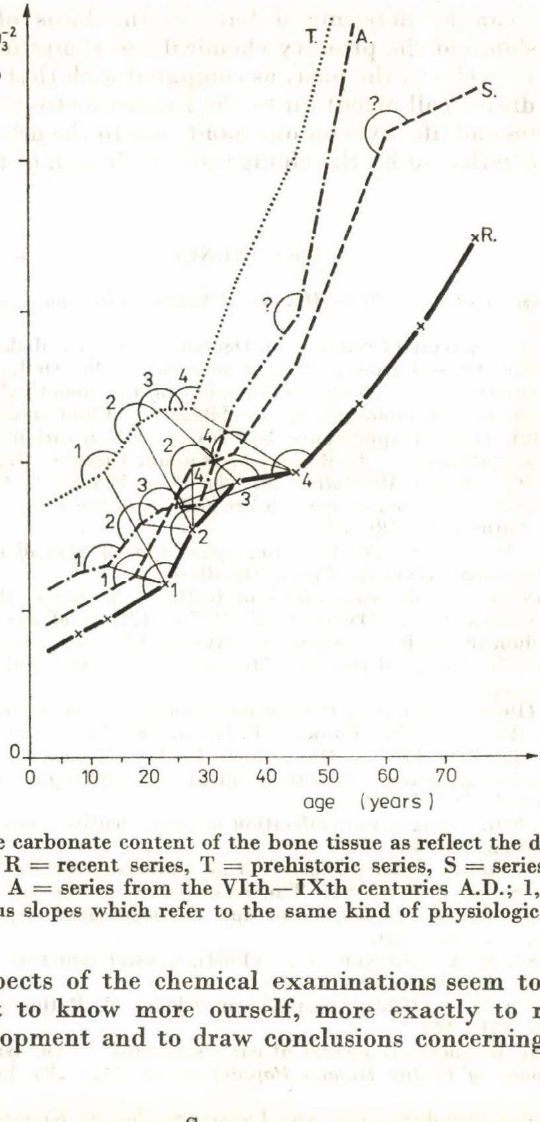


Fig. 10: **Changes of the carbonate content of the bone tissue as reflect the differences in aging processes in the past. R = recent series, T = prehistoric series, S = series from the Xth—XIVth centuries A.D., A = series from the VIth—IXth centuries A.D.; 1, 2, 3 etc. changes of the various slopes which refer to the same kind of physiological events**

The future prospects of the chemical examinations seem to be promising, respectively to get to know more ourself, more exactly to reconstruct the stages of our development and to draw conclusions concerning our biological future, too.

Summary

The author tries to draw conclusions about the dynamism of skeletal aging on the basis of the changes in the chemical composition of the bone tissue. A recent standard. (N = 965) and five archeological (N = 6305) series are constructed for studying the reliabilities of such endeavours. The quantitative changes of the P and CO_3^2 content of the bone tissue proved to be the most suitable chemical age symptoms, while the Ca, collagen and H_2O content could be used only as secondary indices. The results of the new examination method require a revision of the classical, morphological skeletal life cycles. With the help of the chemico-analytical method not only the biological age at death of

the individuals can be determined but, on the basis of the characteristic changes of the slopes of the primary chemical age symptoms, about the length of the several life cycles in the past, as compared with that of the present days. The inferences drawn call attention to the balance between the changes of the human erosystem and life style on one hand, and to the intensity of the adaptation processes as reflected by the changes on the length of the single life cycles, on the other.

REFERENCES

Acsádi, Gy.,—Nemeskéri, J. (1970): *History of Human Life Span and Mortality.* Akadémiai Kiadó, Budapest.

Balogh, K. (1964): Fogászat (Textbook of Dentistry 4th ed.) Medicina, Budapest.

Brown, W. E. (1966): Crystal growth of bone mineral. — Clin. Orthop., *44;* 205—220.

Demisch, A.—Wartmann, P. (1956): Calcification of the mandibular third molar and its relation to skeletal and chronological age in children. — Child Development, *27;* 459—471.

Flecker, H. (1942): Time of appearance and fusion of ossification centers as observed by roentgenographic methods. — J. Roentgen, Radium Therapy, *47;* 97—159.

Fourman, P. (1960): *Calcium Metabolism and the Bone.* Blackwell, Oxford.

Genovés, S. (1960): Reevaluation of age, stature and sex of the Tepexpan remains, Mexico. — Am. J. Phys. Anthropol., *18;* 205—218.

Greulich, W. W.—Pyle, S. I. (1959): *Radiographic Atlas of Skeletal Development of the Hand and Wrist.* — Stanford University Press, Standford.

Gustafson, G. (1950): Age determinations of teeth. — J. Amer. Dent. Ass., *41;* 45—54.

Hansard, S. L.—Comar, C. L.—Davis, G. K. (1954): Effects of age upon the physiological behavior of calcium in cattle. — Amer. J. Physiol., *177;* 383—389.

Holman, H. H. (1962): *Biological Research Method.* — A practical guide. — Oliver and Boyd, Edinburgh, London.

Howells, W. W. (1960): Estimating Population members through archaeological and skeletal remains. — *In:* Heizer, R. F.—Cook, S. F. (Eds): *The Application of Quantitative Methods in Archaeology,* pp. 158—176. — Quadrangle Books, Chicago.

— (1966): Population distances: biological, linguistic, geographic and environmental. — Current Anthropol., *7;* 531—540.

Höhling, H. J. (1969): Collagen mineralisation in bone, dentine, cementum and cartilage. — Naturwissenschaften, *56;* 466.

Jarcho, S. (1966): *Human Palaeopathology.* Yale University Press, New Haven.

Johnston, F. E.—Snow, C. E. (1961): The reessessment of the age and sex of the Indian Knoll skeletal population. Demographic and methodological aspects. — Am. J. Phys. Anthropol., n.s., *19;* 237—244.

Kay, M. I.—Young, R. A.—Posner, A. S. (1964): Crystal structure of the hydroxyapatite. Nature (London), *193;* 369—370.

Kramer, B.—Shear, M. J. (1928): Composition of bone. II. Pathological calcification. — J. Biol. Chem., *79;* 121—123.

Lengyel, I. (1968): Biochemical aspects of early skeletons. — *In:* Brothwell, D. R. (Ed.): *The Skeletal Biology of Earlier Human Population,* pp. 271—288. Pergamon Press, Oxford, London.

— (1973): Allgemeine Grundprinzipien von Laborversuchen an Knochen. — Mitt. Arch. Inst., *3;* 129—143.

— (1976/a): Determination of biological age in the case of ancient dead. — Mitt. Arch. Inst., *5;* 151—161.

— (1976/b): Osteon — osteon-populáció — a szervezet biológiai kora (Osteon — osteon population — the biological age of the organism). Anthrop. Közl., *20;* 69—79.

Martin, R.—Saller, K. (1957): *Lehrbuch der Anthropologie in systematischer Darstellung.* (3rd ed.) Fischer Verlag, Stuttgart.

Mather, K. (1960): *Statistical Analysis in Biology.* Methen et Co. Ltd., London.

McKern, T. W. (1957): Estimation of skeletal age from combined maturation activity. — Am. J. Phys. Anthropol., *15;* 217—230.

Miles, A. E. W. (1963): Dentition in the assessment of individual age in skeletal material. — *In:* Brothwell, D. R. (Ed.): *Dental Anthropology,* pp. 191—209. Pergamon Press, Oxford, London.

MILLER, E. J.—MARTIN, G. R. (1968): The collagen of bone. — Clin. Orthop., *59;* 185—232.
MITCHELL, H. H.—HAMILTON, T. S.—HEGGERDA, F. R.—BEAN, H. W. (1945): The chemical composition of the adult human body and its leaning on the biochemistry of growth. — J. Biol. Chem., *158;* 625—637.
MOYERS, R. E. (1959): Le stade moyen de calcification est indiqué pour chaque dent selon les 10 stades de calcification de la table de Nolla. — Re. Odonto-Stomat., Bordeaux., *9;* 1424—1433.
NEUMAN, W. F.—NEUMAN, M. W. (1958): *The Chemical Dynamics of Bone Mineral.* — The University of Chicago Press, Chicago.
OLIVIER, G. (1960): Practique Anthropologique. — Vigot, Paris.
PELLEGRINO, E. D.—BILTZ, R. M. (1968): Bone carbonate and the Ca to P molar ratio. Nature (London), *220;* 1335—1336.
PYLE, S. I.—HOERR, N. L. (1955): *Radiographic Atlas of Skeletal Development of the Knee.* Thomas, Springfield, Illinois.
ROBINSON, R. A.—WATSON, R. A.—WATSON, M. L. (1955): Crystal-collagen relationship in bone as observed in the electron microscope. — Ann. N. Y. Acad. Sci., *60;* 596—628.
ROGERS, H. J.—WEIDMANN, S. M.—PARKINSON, A. (1952): Studies on skeletal tissues. 2. The collagen content of bones from rabbits, oxen and humans. — Biochem. J., *50;* 537—542.
SHEAR, M. J.—KRAMER, B. (1928): Composition of bone. I. Analytical micromethods. — J. Biol. Chem. *79;* 105—120.
STEWART, T. D. (1957): Rate of development of vertebral sequence of epiphyseal union hypertrophic arthritis and its utility in age estimation. — Am. J. Phys. Anthrop., *19;* 433.
TERMINE, J. D. (1966): *Amorphus calcium phosphate: the second mineral of bone* (Thesis). Cornell University Press.
TODD, T. W. (1924): Thickness of the male white cranium. — Anat. Rec., *27;* 245—256.
VALLOIS, H. V. (1960): Vital statistics in prehistoric population as determined from archaeological data. — *In:* HEIZER, R. F.—COOK, S. F. (Eds): *The Application of Quantitative Methods in Archaeology*, pp. 168—222. Quadrangle Books. Chicago
VAN SLYKE, D. D.—SENDROY, J. JR. (1927): Analytical method for the determination of carbonates in form of CO_2 gas. — J. Biol. Chem., *73;* 127—133.
WINAND, L.—DALLEMANGE, M. J. (1962): Hydrogen bonding in the calcium phosphates. Nature (London), *193;* 369—370.
ZAMBOTTI, V.—BOLOGNANI, L. (1967): Chemical composition and metabolism of cartilage and bone. Symp. Biol. Hung., *7;* 5—9.

Author's address: Dr. LENGYEL IMRE
H-1023 Budapest, Árpád fejedelem útja 44.
Hungary

Anthrop. Közl. *24;* 153–157. 1980.

A FOUR-YEAR STUDY OF PHYSIQUE IN YOUNG BASKETBALL PLAYERS

by J. Mészáros, J. Mohácsi and I. Szmodis

(Department of Medicine, University of Physical Education, Budapest, Hungary; Central School of Sports, Budapest, Hungary)

Abstract. A preliminary comparison was made between the growth rates of 21 boys selected as talented for basketball at the age of 11 and children with normal development and average physical activity. When selected, the basketball group had significantly larger body dimensions than the reference ones, but the form factor metric index was comparable. In the further observations the chest dimensions agreed fully. Dimensional growth ran along the same slopes in both groups. The parallel lines of development were, however, mostly significantly separated. In view of their larger dimensions, the basketball players were close in development to the one year older reference group. This alone, however, was not considered fully sufficient for regarding them as biologically more advanced.

Key words: physique, growth rate trends, basketball players.

Introduction

Higher stature is an essential component or precondition of athletic proficiency in several events of sports. Because of this fact experts responsible for educating young athletes mostly prefer the children who are taller than their age-mates (Szabó 1969). In this early period of development one can hardly tell if the children selected by the coaches are advanced in maturation or else they are endowed with a taller stature. Though coaches usually succeed in choosing children who will eventually become tall adults, assessment of developmental rate may be a kind of objective help to them.

In a long-term observation the goal of this preliminary report was to compare the growth rate of children who when selected for basketball at 11 years of age were taller, to a non-athletic reference group with average stature. Four observations, i.e. a period of 2.5 years between autumn 1976 and spring 1979, are reported on in the present paper.

Material and Methods

The subjects wete 21 boys selected for basketball. In taking weight, stature, chest width and depth, biacromial distance, lower-arm girth and hand circumference the IBP suggestions were observed (Weiner and Lourie 1969). As a reference basis, the cross sectional data of Mészáros and Mohácsi (1978) were used. Body dimensions served also to calculate the index pair of Conrad's growth types (Conrad 1963, Szmodis et al. 1976). The changes in body dimensions and the plastic index were also compared by regression analysis, in which the independent variable was age. Reference values were linearly extrapolated to achieve full correspondence with test-group age. None of these corrections exceeded a quarter of a year.

Results and Discussion

Already at the time of selection the body dimensions of the test group were significantly larger than the reference data (Table 1), and corresponded to those of the one year older reference children. This result points again to the fact that in some sports, as e.g. also in basketball tall stature is an essential criterion in deciding on the aptitude of the candidate for that sport or event.

Table 1

Means and standard deviations of basketball players and non-athletic subjects: Observation 1 (Oct. 16. 1976)

Dimension	Non-athletic		Basketball		t_{B-N}
	$\bar{x}$	s	$\bar{x}$	s	
Body height	143.63	6.81	148.35	8.80	5.27
Body weight	35.73	6.30	39.70	8.38	4.75
Chest depth	15.16	1.50	15.38	1.43	3.66
Chest width	21.60	1.49	22.20	1.54	3.24
Shoulder width	31.10	1.78	31.79	1.93	3.09
Lower arm girth	19.64	1.51	20.59	1.79	4.90
Hand circumference	17.08	1.01	17.63	1.21	4.23
Metric index	−1.14	0.30	−1.15	0.35	0.15
Plastic index	67.99	3.69	70.01	4.60	4.20
N	316		21		

Metric index, the form factor of the chest and thus a measure of body linearity, gave initially a non-significant difference. This similarity of body build can be explained with the rules governing spontaneous development.

Table 2

Means and standard deviations of basketball players and non-athletic subjects: Observation 2 (Jan. 16. 1978)

Dimension	Non-athletic		Basketball		t_{B-N}
	$\bar{x}$	s	$\bar{x}$	s	
Body height	150.00	6.43	155.89	10.08	6.34
Body weight	41.15	7.02	46.54	11.06	5.30
Chest depth	15.98	1.36	16.18	1.46	0.65
Chest width	22.59	1.45	22.89	1.67	0.91
Shoulder width	32.11	1.79	33.20	2.13	4.65
Lower arm girth	20.55	1.57	21.56	1.97	4.83
Hand circumference	17.84	1.09	18.38	1.23	3.84
Metric index	−1.13	0.29	−1.32	0.41	4.72
Plastic index	70.69	3.75	73.13	5.02	4.82
N	277		21		

In the course of observations 2 through 4 (Tables 2 to 4) also hereditary trends may have become manifest, since the chest dimensions have later consistently agreed with the reference values, whereas the difference from reference stature, weight and girths has not changed; in some instances it even grew. Consequently, the metric index became significantly more negative,

Table 3

Means and standard deviations of basketball players and non-athletic (subjects: Observation 3 (Oct. 26. 1978)

Dimension	Non-athletic		Basketball		t_{B-N}
	$\bar{x}$	s	$\bar{x}$	s	
Body height	155.51	6.78	160.32	10.64	4.91
Body weight	44.02	7.92	50.32	10.89	5.80
Chest depth	16.43	1.42	16.59	1.32	0.50
Chest width	23.30	1.58	23.43	1.80	0.36
Shoulder width	33.51	2.11	34.25	2.21	2.77
Lower arm girth	21.24	1.71	22.21	2.05	4.27
Hand circumference	18.26	1.16	18.82	1.24	3.80
Metric index	−1.21	0.35	−1.37	0.44	3.43
Plastic index	73.17	3.21	75.29	5.24	4.49
N	278		21		

Table 4

Means and standard deviations of basketball players and non-athletic subjects: Observation 4 (March 10. 1979)

Dimension	Non-athletic		Basketball		t_{B-N}
	$\bar{x}$	s	$\bar{x}$	s	
Body height	158.63	6.78	164.17	10.86	5.61
Body weight	46.55	7.92	54.06	10.52	6.99
Chest depth	16.75	1.42	17.08	1.56	1.02
Chest width	23.81	1.58	24.07	1.81	0.72
Shoulder width	34.25	2.11	35.05	2.28	2.97
Lower arm girth	21.74	1.71	23.02	1.81	5.90
Hand circumference	18.60	1.16	19.41	1.27	5.46
Metric index	−1.22	0.35	−1.39	0.45	3.62
Plastic index	74.71	3.21	77.47	5.12	5.91
N	278		20		

i.e. the complex trait called leptomorphy became more marked. In view of the general rules of development along growth channels it seems justifiable to assume that these children will retain this more linear build later as well, and also their final stature will be taller than the average and so selecting them was correct.

A similar result was obtained in the regression analysis of body dimensions (Table 5). Except for chest diameters, the respective lines of developmental course are well separated. The identity of growth-rate slopes is, after all,

surprising only to the superficial look. It is hardly conceivable, namely, that 10 to 11 years old children with an average stature should become tall adults 7 to 8 years later. Nevertheless, concerning tall final stature only a continuation of this study can substantiate or disprove the aspirations of the coach and the assumptions of the researcher.

Table 5

Coefficients of the regression equations of growth

Dimension	Group	Individual equations			Adjusted equations		
		Intercept	Slope	r	Intercept	Slope	ta
Height	**B**	**148.33**	**6.43**	**.52**	**148.68**	**6.17**	**6.72**
	N	**143.63**	**6.16**	**.65**	**143.35**	**6.17**	
Weight	**B**	**39.66**	**6.81**	**.47**	**41.52**	**4.45**	**5.84**
	N	**35.78**	**4.36**	**.49**	**35.66**	**4.45**	
Chest d.	**B**	**16.10**	**0.23**	**.14**	**15.56**	**0.62**	**2.24**
	N	15.17	0.65	.41	15.21	0.62	
Chest w.	**B**	**22.13**	**0.74**	**.37**	**21.92**	**0.87**	**1.77**
	N	**21.58**	**0.90**	**.50**	**21.59**	**0.87**	
Biacromial	B	31.73	1.33	.50	31.78	1.29	3.71
	N	30.95	1.29	.53	30.93	1.29	
Lower arm	B	20.52	0.96	.42	20.20	1.19	2.76
	N	19.60	1.21	.32	19.15	1.19	
Hand cirf.	B	17.59	0.79	.47	17.70	0.62	3.88
	N	17.09	0.62	.47	17.08	0.62	
Plastic i.	B	69.88	2.99	.49	70.13	2.76	5.77
	N	67.82	2.74	.60	67.80	2.76	

r: linear correlation coefficient; ta: *t* test value of intercepts; B: basketball players; N: normal non-athletic group.

The increase af linearity (leptomorphy) in the basketball players is not too favourable, despite their larger dimensions. Experience has shown that though the game demands higher stature, the players whose tall stature is associated with a proportionate or robust body build are clearly at advantage (Szabó 1969, Mészáros and Ezer 1978). Coaches who reduce the selection criteria of physical aptitude simply to a taller stature ought to revise their view.

REFERENCES

CONRAD, K. (1963): *Der Konstitutionstypus.* — Springer, Berlin.
MÉSZÁROS, J.—EZER, L. (1978): Testalkati vizsgálatok tapasztalatai kosárlabdázóknál. — Testnevelés- és Sportegészségügyi Szemle *19;* 195—199.
MÉSZÁROS, J.—MOHÁCSI, J. (1978): A gyermekek és serdülőkorúak fejlődésének összefüggései az iskolai testneveléssel. — (Rektori pályázat, Magyar Testnevelési Főiskola.) Budapest.
SZABÓ, J. (1969): Ki lehet kosárlabda játékos? — Kosárlabda *5;* 13.
— (1975): Nincsenek véletlenek. — Kosárlabda *6;* 22.
SZMODIS, I.—MÉSZÁROS, J.—SZABÓ, T. (1976): Alkati és működési mutatók kapcsolata gyermek-, serdülő és ifjúkorban. — Testnevelés- és Sportegészségügyi Szemle *17;* 255—272.
WEINER, J. S.—LOURIE, J. A. (Eds) (1969): *Human Biology — A Guide to Field Methods.* IBP Handbook 9. — Blackwell, Oxford.

Authors' addresses: Dr. MÉSZÁROS JÁNOS
Dr. MOHÁCSI JÁNOS
Dept. Medicine, Hungarian University of Physical Education
H-1123 Budapest, Alkotás u. 44.
Hungary

Dr. SZMODIS IVÁN
Central School of Sports
H-1146 Budapest, Istvánmezei u. 3.
Hungary

Anthrop. Közl. 24; 159—163. 1980.

SOMATOTYPE AND SELECTED ANTHROPOMETRIC COMPARISONS OF CANADIAN AND GUYANESE CHILDREN

by D. C. Milne and M. Shamess

(Faculty of Physical Education, University of Western Ontario, London, Ontario, Canada)

A b s t r a c t. As part of a larger World University Services of Canada project dealing with problems of development in Third World countries, this study compared the somatotypes and other selected anthropometric measurements of 10-year-old Canadian and Guyanese male children.

The Canadian sample consisted of 174 ten-year-old males from the Saskatchewan Growth Study while the Guyanese sample consisted of 35 ten-year-old males representative of the population from Georgetown, Guyana. All anthropometric measurements taken followed the procedures of the Heath—Carter Somatotype Method.

The somatotype distribution of the Canadian males displayed an average somatotype rating of 2.5—4.0—3.6, a *mesomorph-ectomorph*, with the largest identified category, at 30 per cent, being mesomorph-ectomorph.

The somatotype distribution of the Guyanese males displayed an average somatotype rating of 2.9—3.5—3.8, a *mesomorph-ectomorph*, with the largest identified category, at 27 per cent, being *balanced ectomorph.*

Comparison of the average somatotype ratings indicated the Canadian males to be significantly higher in the mesomorphic component whereas the Guyanese males were significantly higher in the endomorphic component ($p \leq .05$).

Comparison of selected anthropometric measures indicated the Canadian males to have significantly larger calf girths whereas the Guyanese males were significantly larger in the skinfolds of the triceps and subscapula.

Various factors were speculated to have influenced the growth patterns of these children.

Key words: somatotypes, anthropometric, children, Canada, Guyana.

Introduction

The physical growth and developmens of children from industrialized countries of the western world has been well documented (Malina 1971, Tanner et al. 1966, Johnston et al. 1970, Bailey 1972). There is however, a very limited number of anthropometric studies from developing countries (Firsancho et al. 1975, Malina et al. 1974, Johnston et al. 1975, Glanville and Geerdink 1970).

As part of a World Univetsity Services of Canada project to expose and familiarize Canadians to development of Third World countries, this study was undertaken to (a) describe the somatotypes of a representative group of 10-year-old Guyanese males, and (b) compare the somatotypes and selected anthropometric measures of Guyanese and Canadian 10-year-old males.

Methodology

The original Guyanese sample consisted of 69 ten-year-old children, 35 males and 34 females. From this male group there were 18 Afro-Guyanese, 4 Indo-Guyanese and 13 mixed Guyanese 10-year-olds all of whom were of similar socio-economic status and attending a community school in the capital city of Georgetown.

The children were measured for height without shoes and weighed in light cotton school uniforms on a lever balance scale. All anthropometric measurements were taken following the procedures outlined by the Heath—Carter Somatotype method (CARTER 1972).

The Canadian data were obtained from the Saskatchewan Child Growth and Development Study (BAILEY 1972).

Results and Discussion

Somatotype patterns

The distributions of the various somatotypes for the Guyanese and Canadian 10-year-old males were plotted by a computer program on the Heath—Carter somatocharts and are shown in Figures 1 and 2.

Figure 1A displays the distribution of somatotypes of 10-year-old Guyanese males having an average somatotype rating of 2.9—3.2—3.8, a *mesomorph-ectomorph.* The latgest identified category at 27 per cent was balanced ectomorphs (the third component is dominant and the first and second components are equal and lower or do not differ by more than one-half unit). Meso-

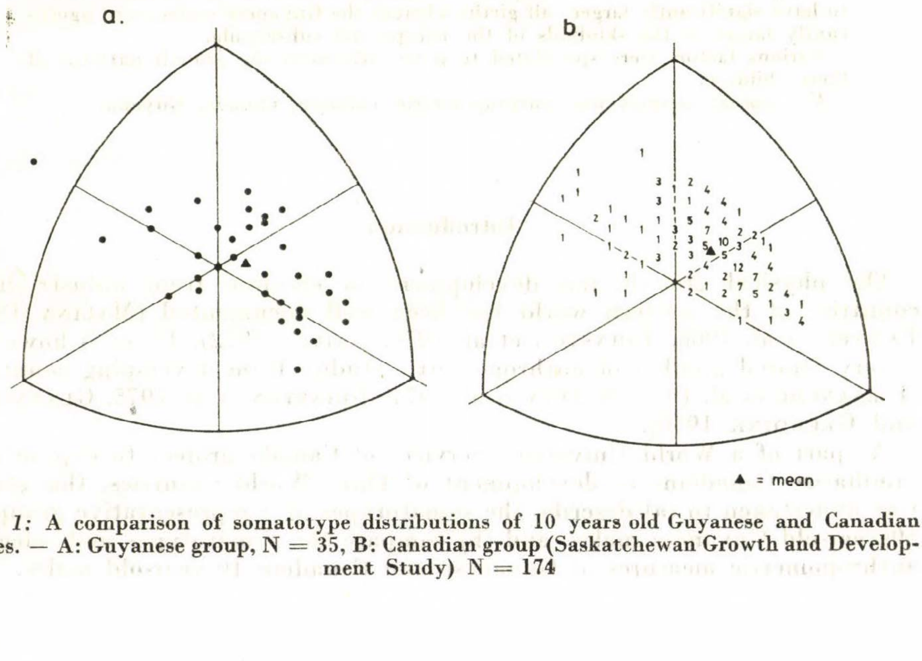


Fig. 1: A comparison of somatotype distributions of 10 years old Guyanese and Canadian males. — A: Guyanese group, N = 35, B: Canadian group (Saskatchewan Growth and Development Study) N = 174

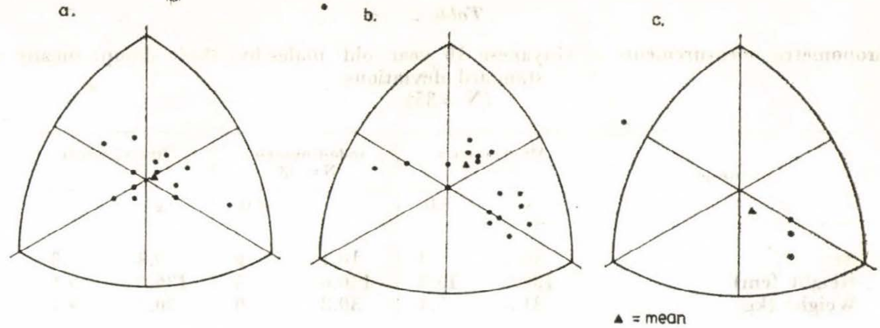


Fig. 2: A comparison of somatotype distributions of 10 year old Guyanese males by ethnic sample. — A: Mixed Guyanese males, N = 13; B: Afro-Guyanese males, N = 18; C: Indo-Guyanese males, N = 4

morph-ectomorph (second and third components do not differ by more than one-half unit and the first component is lower) was the second largest classification at 13.5 per cent, followed by balanced endomorphs at 10.8 per cent.

Figure 1B displays the somatotype distribution of 10-year-old Canadian males indicating an average somatotype rating of 2.5—4.0—3.6, a *mesomorph-ectomorph*. The largest identified category was the mesomorph-ectomorph at 29.3 per cent, followed by mesomorphic-ectomorph at 21.8 per cent, balanced mesomorphs at 18.4 per cent and ectomorphic-mesomorphs at 13.8 per cent.

Table 1

Anthropometric comparisons of Canadian and Guyanese 10 year old males: means and standard deviations

	Canadian N = 174		Guyanese N = 35	
	x̄	S.D.	x̄	S.D.
Age	10.0	.3	10.1	.4
Height (cm)	138.5	6.5	136.7	11.8
Weight (kg)	31.9	5.2	30.9	5.5
Skinfolds (mm)				
Triceps	8.9	3.0	10.1*	3.6
Subscapula	6.1	2.7	7.6*	3.6
Suprailiac	5.6	3.1	5.9	4.4
Medial calf	—	—	12.7	3.8
Bone diameters (cm)				
Humerus	5.6	.3	5.4	.7
Femur	8.4	.5	8.2	.4
Girths (cm)				
Biceps	19.8	1.9	20.2	2.3
Calf	27.1*	2.0	25.9	4.8

* Significant at .05

Table 2

Anthropometric measurements of Guyanese 10 year old males by ethnic group; means and standard deviations (N =35)

Items	Afro-Guyanese N = 18		Indo-Guyanese N = 13		Others (mixed) N = 4	
	x̄	S.D.	x̄	S.D.	x̄	S.D.
Age	10.1	.4	10.1	.6	9.8	.3
Height (cm)	136.0	15.8	136.6	6.5	136.0	5.1
Weight (kg)	31.5	5.4	30.3	3.9	30.2	9.4
Skinfolds (mm)						
Triceps	8.9	3.2	11.7	3.6	8.7	2.1
Subscapular	7.3	3.9	7.7	2.1	9.9	6.1
Suprailiac	5.3	3.3	4.9	1.9	9.2	9.3
Medial calf	11.9	4.1	14.6	3.2	11.8	4.0
Bone Diameters (cm)						
Humerus	5.36	.27	5.54	1.09	4.98	.38
Femur	8.27	.36	8.07	.39	8.13	.81
Girths (cm)						
Biceps	20.7	1.9	19.9	2.1	19.5	3.9
Calf	25.7	6.6	26.4	1.7	25.5	3.4
Somatotype Components						
1st (endomorphy)	2.7	1.3	3.1	.9	3.5	2.1
2nd (mesomorphy)	3.8	2.1	3.5	.7	3.0	2.0
3rd (ectomorphy)	3.7	1.4	3.5	1.1	4.0	2.3

Comparing the average somatotype ratings of the two samples indicated that the Canadian males were significantly higher ($p \leq .05$) in the mesomorphic component while the Guyanese were significantly higher ($p \leq .05$) in the endomorphic components. No differences were indicated in the ectomorphic component.

Since the Guyanese sample was composed of three ethnic subgroups, Figure 2 displays the somatotype distributions of 10-year-old Mixed Guyanese, Afro-Guyanese and Indo Guyanese males, respectively.

Figure 2A indicates that the average somatotype of Mixed-Guyanese 10-year-old males was 3.1—3.5—3.5, a *mesomorph-ectomorph.* The largest identified categories were mesomorph-ectomorph and central (no component differs by more than one unit from the other two and consists of ratings of 3 and 4) at 23.1 per cent each.

In Figure 2B the average somatotype for Afro-Guyanese 10-year-old males was 2.7—4.1—3.7, a *mesomorph-ectomorph.* The largest identified category was balanced ectomorph at 27.8 per cent, followed by mesomorph-ectomorph and mesomorphic-ectomorphs at 16.7 per cent each.

Figure 2C indicates the average somatotype of Indo-Guyanese 10-year-old males to be 3.5—3.0—4.0 although the sample size is quite small. The dominant category was *balanced ectomorphs.*

Anthropometric comparison

For a more specific anthropometric comparison between Canadian and Guyanese 10-year-old males, the two groups were compared on 9 body measurements. Table 1 indicates significant differences ($p \leq .05$) in favour of the Guyanese in the tricep and subscapula skinfolds and the Canadians in the calf girth.

Although it appears the Guyanese children may have more body fat, this conclusion could be misleading, due to the small number of fat sites employed and the confounding of racial fat pattern depositions.

Table 2 compared the three Guyanese ethnic groups on 10 anthropometric measurements. No significant differences were identified. Although there are obvious racial differences, a common diet may hide any real differences.

REFERENCES

BAILEY, D. A. (1972): *Saskatchewan Child Growth and Development Study.* Progress Report. *No. 9.* — College of Phys. Educ., University of Saskatchewan, Saskatoon, Saskatchewan.

CARTER, J. E. LINDSAY (1972): *The Heath-Carter Somatotype Method.* San Diego, Cal: San Diego State College, 1972.

FIRSANCHO, A. R.—BROKAN, G. A.—KLAYMAN, J. E. (1975): Pattern of Growth of Lowland and Highland Peruvian Quechua of Similar Genetic Composition. — Human Biology, *47;* 233—243.

GLANVILLE, E. V.—GEERDINK, R. A. (1970): Skinfold Thickness, Body Measurements and Age Changes in Trio and Wajana Indians of Surinam. — Am. J. Phys. Anthrop., *32;* 455—462.

HEATH, B. H.—CARTER, J. E. L. (1977): Growth and Somatotype Patterns of Manus Children, of Papua and New Guinea: Application of a Modified Somatotype Method to the Study of Growth Patterns. — Am. J. Phys. Anthrop., *35;* 49—68.

JOHNSTON, F. E.—DECHOW, P. C.—MACVEAN, R. B. (1975): Age Changes in Skinfold Thickness among Upper Class School Children of Differing Ethnic Backgrounds Residing in Guatemala. Human Biology, *47;* 251—262.

JOHNSTON, F. E.—HAMILL, Y.—LENESHOW, S. (1970): *Skinfold Thickness of Children 6—11 years, United States.* National Centre for Health Statistics, Vital and Health Statistics, Series 11 — Number *120.*

MALINA, R. M. (1971): Skinfolds in American Negro and White Children. — J. Am. Dietet. Assoc. *59;* 34—40.

MALINA, R. M.—HABICHT, J. P.—YARBOROUGH, C.—MARTORELL, R.—KLEIN, R. E. (1974): Skinfold Thicknesses at Seven Sites in Rural Guatemalan Ladino Children Birth Through Seven Years of Age. — Human Biology, *46;* 453—469.

ROBSON, J. R. K.—BAZIN, M.—SODERSTROM (1971): Ethnic Differences in Skinfold Thickness. — Am. J. of Clinical Nutrition *24;* 864—868.

TANNER, J. M.—WHITEHOUSE, R. H.—TAKASHI, M. (1966): Standards from Birth to Maturity for Height, Weight, Height Velocity and Weight Velocity; British Children. 1965. — Arch. Dis. Child. *41;* 454—471; 613—635.

Authors' address: Dr. CONRAD MILNE
MARGARET SHAMESS
Undergraduate Office,
Faculty of Physical Education University of Western Ontario
London, Ontario N6A 3K7
Canada

Anthrop. Közl. *24:* 165–171. 1980.

INFLUENCE OF VOLUNTARY WEIGHT REDUCTION ON THE SOMATO-SEXUAL DEVELOPMENT OF GIRLS

by J. Örley–K. Frank and M. Istók

(Department of Obstetrics and Gynaecology and Department of Pediatrics, Postgraduate Medical School, Budapest, Hungary)

Abstract. Among 15.462 young girls — who were treated for different gynaecological disorders by the author mentioned first, in Budapest 1966–1979 — 761 were excessively obese (4.92%). The calculations were correlated with the total number of examined patients' age, thus a peak could be observed between ages of 6–10, and later between ages of 12–14 years. The percentage of obesity was larger in the quiet period than in the prepuberal–puberal ages. Of this sample 101 young obese girls were controlled quarterly by biosomatic measurements together with hormonal parameters (as FSH, LH, hPRL, urinary oestrogens, 17KS) and cytohormonal smears. An anorexigenic drug (Desopimon tbl.) was rarely administred. Most of the observed girls had a regimen of voluntary weight reduction. Those who regained the upper normal limit in weight according to height and age became gynaecologically healthy, free of formal disorders and menstrual irregularities (amenorrhoea secundaria, raromenorrhoea).

Key words: somato-sexual development, obese girls, genital diseases and disorders, voluntary weight reduction.

Introduction

In a permanent work of pediatric gynaecology performed by the author mentioned first from October 1966 to March 1979 among 15.462 new patients it was discovered that obesity itself caused a lot of problems in the field of the female sexual organs, although the disorders were of asexual nature. It was observed that in the so-called "hormonally quiet period" (from the age of 2 months up to 9—10 years of age) when physiologically the external and internal sexual organs do not exhibit any signs of hormonal influences, obesity predisposed for recurrent genital inflammations, by the vaginal milieu altered in comparison with the non-obese contemporaries of the patients. After menarche, as is well-known, obesity is associated with different forms of menstrual disorders, mainly with raromenorrhoea.

Material and Methods

Table 1 shows that 4.92 per cent of the patients were obese, over 85 percentile. The calculations were correlated with the total number of examined patients in the respective ages.

It can be observed that there is a peak between 6—10 and later between 12—14 years of age. The percentage of obesity is larger in the quiet period

Table 1

Percentage of obese girls among 15,462 new patients in Budapest, 1966–1979

Age (years)	All patients	Obese girls N	Obese girls %
1–11 months	140	1	0.71
1 years	147	—	—
2	526	3	0.57
3	773	7	0.90
4	749	16	2.15
5	745	17	2.28
6	749	45	6.00
7	707	58	8.20
8	840	60	7.14
9	653	44	6.73
10	683	59	8.63
11	822	42	5.10
12	1082	69	6.37
13	1367	86	6.29
14	1546	94	6.00
15	1251	55	4.39
16	948	45	4.74
17	937	34	3.62
18	797	26	3.26
	15,462	761	4.92

than in the prepuberal-puberal age (8.0%, respectively 6.4%). Naturally, the heaviest weight observed (126 kgs = 277.53 ps) was manifested in adolescence. From this sample of patients we selected and serially followed up 101 young obese girls (Table 2).

Table 2

Age distribution of 101 obese patients

Age (years)	Obese girls N	Obese girls %
6	2	1.98
7	2	1.98
8	3	2.97
9	13	12.87
10	14	13.86
11	10	9.90
12	7	10.89
13	11	6.93
14	13	12.87
15	10	9.90
16	11	10.89
17	4	3.96
18	1	0.99

The two youngest were 6 years, the oldest one was 18 years old. These girls were controlled quarterly. Their survey included a brief anamnesis and a complete gymnaecological examination. At all times culture methods were used to determine the vaginal flora. Aerobic pathogen bacteria, yeast-like fungi and other parasites like *Trichomonas vaginalis* and *Enterobius vermicularis* were searched for. In the older girls, the examination was completed with taking the basal body temperature, body measurements and the menstrual irregularities also were very carefully recorded.

The menstrual cycles were followed by cytohormonological smears with Papanicolaou-dye. The following hormone measurements were made by the radioimmunoassay technique: FSH, LH, HPRL, TSH, T_3, T_4 and sometimes, testosterone. The level of serum cholesterin was measured and 17 KS were calculated on a 24 hours collected sample of urine. The parallel assessment of baseline thyroid function was needed for a considerable evidence from both animal experiments and studies in hypothyroid patients (Borodistky and Faiman 1973, Distiller et al. 1975, Kramer et al. 1979, Wolf 1977), that thyroid deficiency may directly lead to an impairment of gonadotropin secretion. The hormone values were within normal limits.

Regarding the body measurements (weight, height, chest circumference, abdomen circumference, length of the upper and lower extremities, biceps girth, calf girth, bicondylar width of the humerus and femur) were taken with Martin's technique (Martin—Saller 1957—66). The skinfold thicknesses were measured with a Hungarian type of Lange skinfold calipers, by standard techniques on the left side of the girls on the following places: triceps, subscapular, suprailiac, umbilical, and calf. Distribution by weight and height of these patients were referred to the Budapest cross-sectional standards of Eiben et al. (1971). The percentage of the ideal weight referred to height was calculated with Eiben's reference data for each age. With this index value obesity was stated over 120%, overweight at 110%—120%. In starting of this study, obesity was diagnosed in 82 girls (81.1%), 19 ones were overweighted (18.8%). Also Kaup's index was calculated for this sample (weight in grams divided by height in square), then it was referred to this index given at each age, before and after the voluntary weight reduction (Eiben 1960).

The percentage of body fat was calculated on the triceps and subscapular skinfold thicknesses by means of Pařísková's following regression equation (Pařisková and Roth 1972):

$$y = 41.012\ x—33.684,$$

where y is the percentage of body fat, x = logarithm of the sum of triceps and subscapular skinfolds. The percentage of body fat varied between 31.1 to 41.6 in authors' sample.

Together with the clinical examinations, in the beginning, all patients had to undergo tests of psychological designs, so that obvious deformities in psychic development could be excluded. Preceding prepuberal development no signs of infantilism could be detected in these designs, yet in older girls they became somewhat primitive and rigid. The obese girls exhibited a tendency to play masculin roles, that is, they wear trousers rather than skirts and did men's sports e.g. throwing events in athletics, they chose virile professions e.g. gentlemen's hair-dresser. Generally, each showed clear psychic possession of her physical force and very often misused it. Later, when they lost the

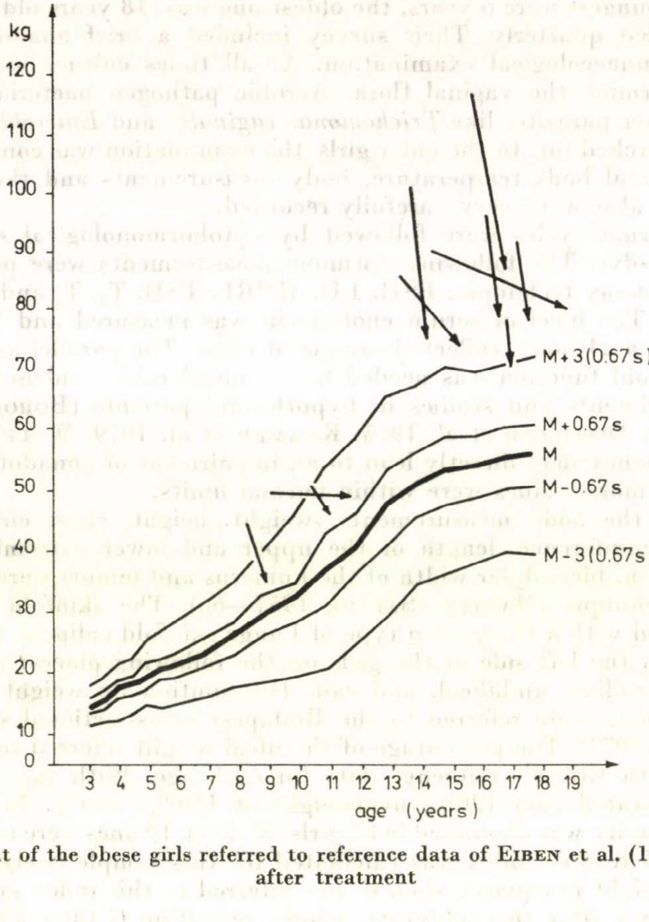


Fig. 1: Weight of the obese girls referred to reference data of EIBEN et al. (1971), before and after treatment

excess, they became quite happy and well-balanced, leading a normal female life.

It should be emphasized, that these girls came for consultation of purely gynaecological nature. The diagnoses of their complaints are enumerated in Table 3. All had inflammatory diseases in the external genital areas; 43 were before menarche (42.5%) and 58 were after it (57.5%).

Treatment

The treatment consisted of dietary restriction of weight forced physical activities, e.g. sports. For the gynaecological diseases the convenient treatment was established, however, without any use of hormones. If no reliable result could be attained during the first three months of observation, or in the cases where the degree of obesity was extreme (over 170%), an anorhexigenic drug, chlorphenterminum hydrochloricum Desopimon EGYT was administered twice 25 mg daily. All of the 19 patients got Desopimon tablets (18.8%), 4 of them used it afterwards following an unsuccessful dietary regime.

Table 3

Genital diseases and disorders in 101 obese patients

Diagnoses	Patients N	Patients %
a) Inflammations		
Vulvovaginitis ac.	42	41.6
out of them		
E. coli vaginitis	21	
vaginal mycosis	6	
enterobiosis	4	
trichomoniasis	3	
other	8	
Vulvovaginitis chr.	27	26.7
discharge with prur.	32	31.7
b) Menstrual disturbances		
raromenorrhoea	27	46.6
amenorrhoea sec.	6	10.3
pollakymenorrhoea	4	6.9
polymenorrhoea	2	3.5
metropathia juv.	1	1.7
sine morbo gyn. int.	18	31.0

Before menarche were 43 girls, after menarche were 58 girls.

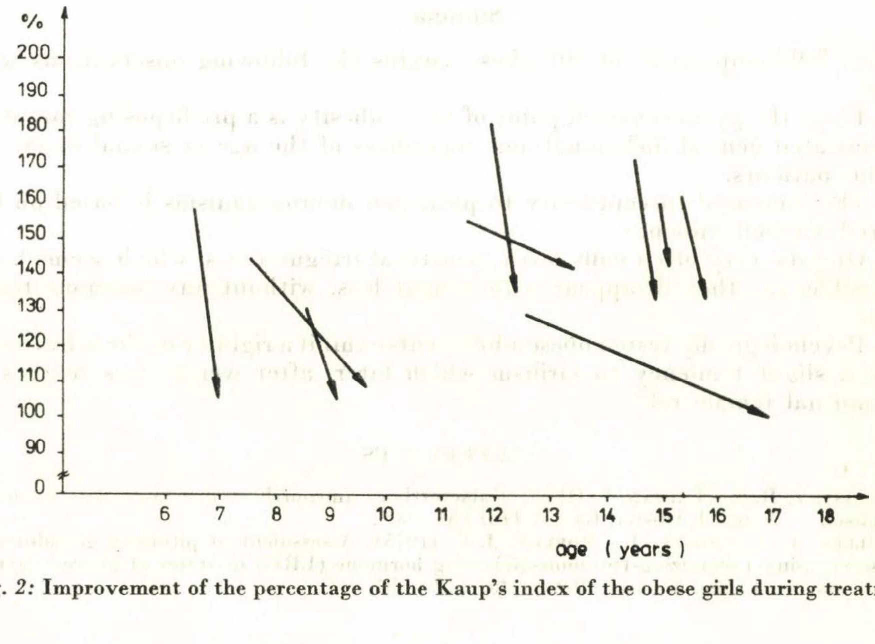


Fig. 2: **Improvement of the percentage of the Kaup's index of the obese girls during treatment**

Results and Discussion

The cessation of the clinical features went parallel with voluntary weight reduction. On the occasion of the last revision, those who lost a considerable amount of weight, became free of symptoms and complaints as to gynaecological health.

The percentage of weight loss is calculated with both reference data of EIBEN et al. (1971) and Kaup's index referred to age.

A great decrease in the value of Kaupís index (30% to 60%) was presented in 9 patients (8.91%), the other 24 patients (23.7%) showed a moderate decrease (10% to 30%). In 27 (26.7%) patients no weight reduction could be attained and there was no improvement in their gynaecological state.

From the angle of the practicing pediatric gynaecologists, obesity can be considered as a very serious condition with a view to repeated genital inflammations or menstrual irregularities. The interpretation of this increased susceptibility to pathogen microorganisms lies in the altered vaginal milieu, caused by the increase of fat in the tissues, by concomitant rise of pressure and humidity. The loss of weight restores the normal bioflora of the vagina with its defensive mechanisms. In case of menstrual irregularities in obese patients who after weightloss have resumed normal menstrual activity, this is a well-known experience of the practice. The authors could confirm this observation by the number of their healed patients 17 out of 27 raromenorrhoeic girls started regularly menstruating again after a voluntary weight reduction. Since all our patients were euprolactinemic and the other baseline hormone values were within the normal range, the authors agree with the opinion of KRAMER et al. (1979) that there may have been a very subtle hypothalamic defect in these obese girls which involved LHRH as well as TRH. The authors intend to study this subtle function in obese girls in the future.

Summary

In a follow-up study of 101 obese virgins the following observations were made.

1. From the gynaecological point of view, obesity is a predisposing condition for repeated genital inflammations, regardless of the age or sexual inactivity of the patients.

2. The increased susceptibility to pathogen microorganisms is based on the altered vaginal milieu.

3. Obesity very often calls forth menstrual irregularities, which seems to be reversible, i.e. they disappear with weight loss, without any hormone treatment.

4. Psychologically tested obese adolescents exhibit a rigidity in the behaviour), have a slight tendency to virilism which later, after weight loss returns to the normal female role.

REFERENCES

BORODISTKY, R. S.—FAIMAN, C. (1973): Galactorrhoea-amenorrhoea due to primary hypothyroidism. — Amer. J. Obstet. Gynec. *116;* 661—665.

DISTILLER, L. A.—SAGEL, J.—MORLEY, J. E. (1975): Assessment of pituitary gonadotropin reserve using Luteinizing-Hormone-Releasing hormone (LRH) in states of altered thyroid function. — J. clin. Endocr. Metab. *40;* 512—515.

EIBEN, O. G. (1960): Nomogram to the Kaup's index (in Hungarian). — Anthrop. Közl. *4;* 53—56.

EIBEN, O.—HEGEDŰS, G.—BÁNHEGYI, M.—KIS, K.—MONDA, M.—TASNÁDI, I. (1971): *Budapesti óvodások és iskolások testi fejlettsége (1968—1969).* — Budapesti Fővárosi KÖJÁL, Budapest.

KRAMER, M. S.—KAUSCHANSKY, A.—GENEL, M. (1979): Adolescent secondary amenorrhoea: Association with hypothalamic hypothyroidism. — J. Pediat. *94;* 300—303.

MARTIN, R.—SALLER, K. (1957—1966): *Lehrbuch der Anthropologie* I—IV. (3. Ed.) — G. Fischer, Stuttgart.

PAŘÍSKOVÁ, J.—ROTH, Z. (1972): The assessment of depot fat in children from skinfold thickness measurements by Holtain (Tanner—Whitehouse) caliper. — Human Biol. *44;* 613—620.

WOOLF, P. D. (1977): Hypothyroidism and amenorrhoea due to hypothalamic insufficiency. — Amer. J. Med., *63;* 343—347.

Authors' addresses: Dr. ÖRLEY JUDIT
Clinic of Obstetrics and Gynaecology, Postgraduate Medical School
H-1135 Budapest, Szabolcs u. 33—35.
Hungary

Prof. Dr. FRANK KÁLMÁN
Dr. ISTÓK MÁRTA
Clinic of Peadiatrics, Postgraduate Medical School
H-1135 Budapest, Szabolcs u. 33—35.
Hungary

Anthrop. Közl. *24;* 173–178. 1980.

VARIATIONS OF PHYSIQUE IN FEMALE COLLEGE STUDENTS

by J. Pápai

(Teachers' Training College, Jászberény, Hungary)

Abstract. Four groups of female students from Teachers' Training Colleges: in Debrecen (Eastern Hungary, n = 276), in Jászberény (Middle Hungary, n = 267), in Kecskemét (Middle Hungary, n = 241), and in Sárospatak (Northern Hungary, n = 285) were studied. All students were Hungarian and Caucasian; their age varied between 18 and 21 years. Based on a detailed anthropometric program, their body dimension and proportion were analyzed by means of Ross–Wilson's (1974) unisex human phantom, and their somatotype determined by the Heath–Carter method.

The mean stature of the complete sample was 160.77 cm, the mean somatotype 5.79–3.17–2.04. Some geographic regional differences among the four groups were noted only in length measurements. The Jászberény-group was the tallest (161.04 cm). No significant differences were observed in other body measurements, proportions or somatotypes.

Key words: physique, body proportions, somatotype, female students, Debrecen, Jászberény, Kecskemét, Sárospatak.

Introduction. Material and Methods

Ever since Sheldon et al. (1940) carried out his classical examinations in university students, the variations of physique of juveniles and young adults can count upon the interest of human biologists.

The author of the present paper conducted her examinations in 1973 and 1974 founding herself on a detailed anthropometric programme, in the Debrecen (n = 276), Sárospatak (n = 285) and Jászberény (n = 267) Teachers' Training Colleges, as well as in the Kecskemét Training College for Kindergarten Teachers and Nurses (n = 241). The ages of the 1069 female students vary between 18 and 21 years, the mean of their ages is 19.58 years. All are Hungarians, Europids.

Results and Discussion

In Figure 1 the places are presented where the examinations took place. The samples originate from Eastern Hungary (Debrecen), Northern Hungary (Sárospatak) and Central Hungary (Jászberény, Kecskemét). It can be found that, as compared with data of earlier examinations conducted in Hungary, the stature has increased; the measure of the secular trend is similar to the one

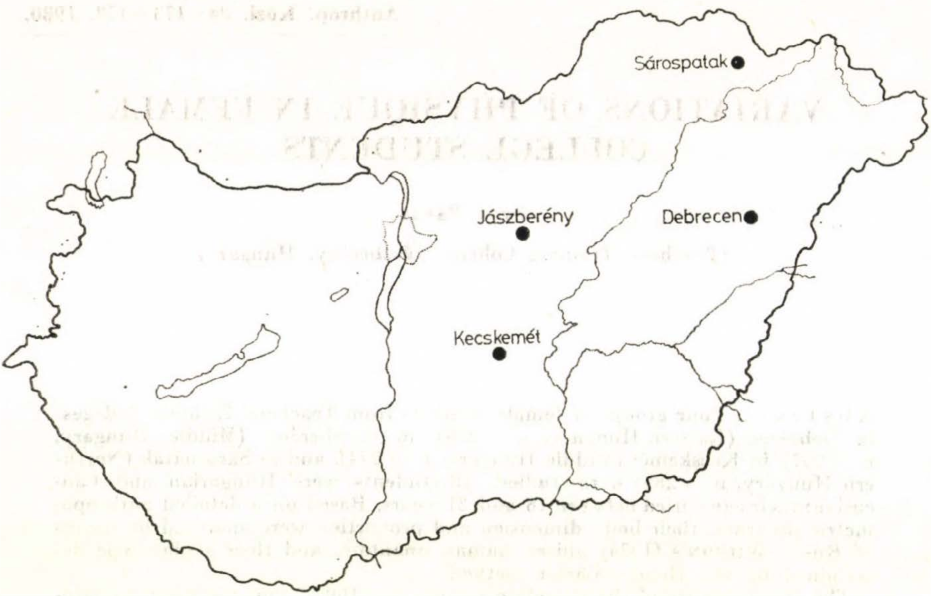


Fig. 1: **Sites of collection of the sample**

in other European countries (RAJKAI—JANCSÓ 1955, RAJKAI 1957, 1965, EIBEN 1965, BARACS—FARMOSI 1976, EVELETH—TANNER 1977, COLLINS—WEINER 1977).

The tallest in the samples are the Jászberény girls ($\bar{x} = 161.04$ cm). Upon them follow the Sárospatak ones with a mean of 160.74 cm, the Debrecen ones ($\bar{x} = 160.50$ cm) and, finally, the Kecskemét ones ($x = 160.29$ cm). In mean stature there is no significant difference between the subgroups. On the other hand, in the measurements of stature length there are significant differences to be demonstrated. The female students from Debrecen and Sárospatak, i.e. from Northeastern Hungary do not significantly differ from each other, the values of their measurements are similar. The means of the Jászberény girls (Central Hungary) significantly differ from the former: their values of size and shape are higher.

Making use of the unisex human phantom (ROSS—WILSON 1974) the author conducted proportional analysis. The Jászberény subgroup differs from the others also as to proportions. A similitude in proportions of the Debrecen and Sárospatak groups can be demonstrated.

Figure 2 shows the z-transformation values of the measurements of lengths.

The differences appearing in the measurements and proportions of length are due to the fact that in the examined areas the ethnic structure of the population is different. Interbreeding, the discontinuance of the geographic determining effects could not dissolve the differences in these genetically so closely bound measurements to our very days. This difference in stature of the female college students come from various regions of Hungary can be compared with the results brought by a survey of males liable to conscrip-

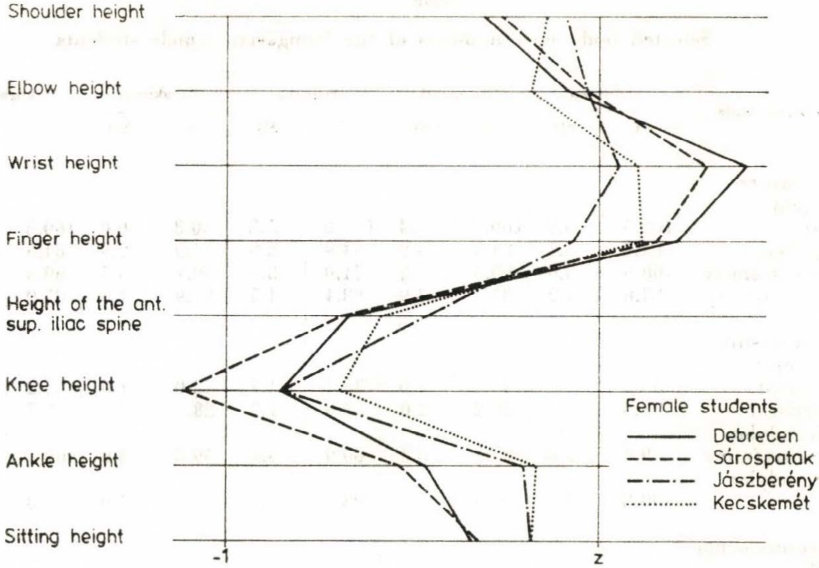


Fig. 2: **Proportional profile of length measurements of the female students**

tion (KÁDÁR—VÉLI 1971, 1974, 1977, NEMESKÉRI et al. 1977). Accordingly, in Hungary the statures of young adult population of both sexes differ by geographic regions. The differences appear more markedly with the males than with the females.

In the case of the measurements of width and circumference the author could not find such a tendency. These characters are much more determined by the environment and vary depending on it (Table 1).

The author determined the physique relying upon Heath—Carter's method (CARTER 1975). The mean values of the somatotype of the whole sample are: 5.79—3.17—2.04. As it appears from the distribution, the majority of the

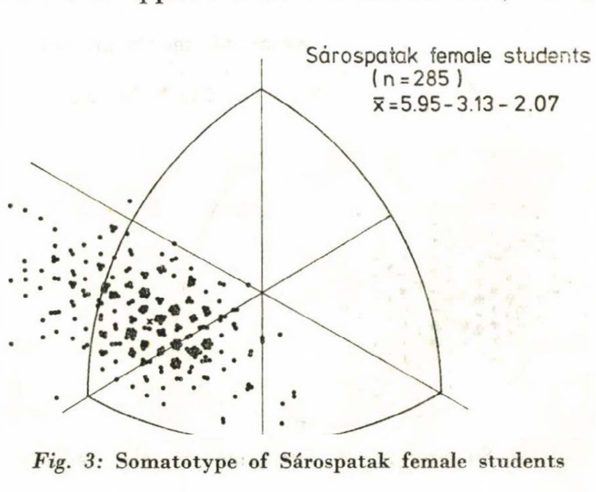


Fig. 3: **Somatotype of Sárospatak female students**

Table 1

Selected body measurements of the Hungarian female students

Body measurements	Debrecen x̄	Debrecen SD	Sárospatak x̄	Sárospatak SD	Jászberény x̄	Jászberény SD	Kecskemét x̄	Kecskemét SD	Together x̄	Together SD
Length measurements (cm)										
Stature	160.5	5.9	160.7	5.4	161.0	5.8	160.3	6.0	160.8	5.7
Sitting height	84.2	3.1	84.3	3.2	84.9	2.9	84.9	2.9	84.5	3.0
Upper extremity	68.9	3.0	69.3	3.2	71.0	3.4	70.1	3.5	69.8	3.4
Lower extremity	87.8	4.2	87.5	3.9	88.4	4.5	87.9	4.5	87.9	4.2
Breadth measurements (cm)										
Bi-acromial	35.3	1.5	35.4	1.6	35.1	1.7	35.0	1.6	35.2	1.6
Bi-iliocristal	28.5	1.9	29.2	2.0	28.6	1.8	28.4	2.0	28.7	2.0
Bi-epicondylar humerus (mm)	59.8	2.8	60.8	3.2	60.9	3.4	59.8	3.6	60.3	3.3
Bi-epicondylar femur	90.8	4.8	92.0	5.3	93.6	5.6	91.6	4.9	92.0	5.3
Girth measurements (cm)										
Chest	82.0	4.5	83.5	4.5	82.0	4.3	81.1	4.5	82.2	4.5
Abdominal	77.2	5.8	78.2	6.5	76.9	6.4	77.6	6.5	77.5	6.3
Thigh	54.3	3.4	54.9	4.1	54.3	4.0	53.8	4.1	54.4	3.9
Arm (extended)	24.3	1.7	24.7	2.1	24.6	2.0	23.9	2.2	24.4	2.0
Skinfolds (mm)										
Triceps	19.6	5.2	21.4	5.4	22.4	5.3	23.2	5.0	21.6	4.9
Suprailiac	29.0	7.9	28.9	7.3	24.7	6.8	24.6	7.5	26.9	7.6
Weight (kg)	54.5	6.0	55.9	6.7	57.5	6.9	55.4	7.4	55.9	6.8
Somatotype										
Endomorphy	5.7	1.1	5.9	1.0	5.7	1.1	5.8	1.1	5.8	1.1
Mesomorphy	3.2	0.9	3.1	1.0	3.2	1.1	3.1	1.1	3.2	1.1
Ectomorphy	2.2	1.0	2.1	1.0	1.8	1.0	2.0	1.0	2.0	1.0

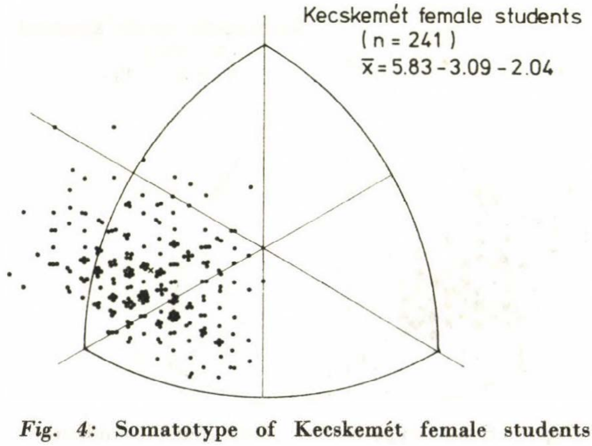


Fig. 4: **Somatotype of Kecskemét female students**

students is mesomorphic-endomorphic. The mean value of the Ist component is highest among the Sárospatak (5.95) and Kecskemét (5.83) girls. The means of the Jászberény and Debrecen subgroups agree. Still, the identical means cover different body structures: in the Jászberény girls there is more fat on the upper armes and back (subscapula), while with the Debrecen subgroup it is the fat deposits of the pelvic (suprailiac) region that are more marked.

The means of the IInd component are nearly identical in each subgroup. As to absolute values, the mean of the Jászberény group is the highest (3.24). The data of the wrist- and ankle circumferences as well as the bicondylar width indicate that the bony system of this group is stronger than that of the others. True, as to measurements of circumference, they follow after the Sárospatak girls, still while with the latter subcutaneous fat occurs in greater quantity, the lower values of circumference cover larger masses of muscles.

The values of the IIIrd component show that the Debrecen girls are the most ectomorphic ones of the surveyed individuals (Figures 3, 4, 5 and 6).

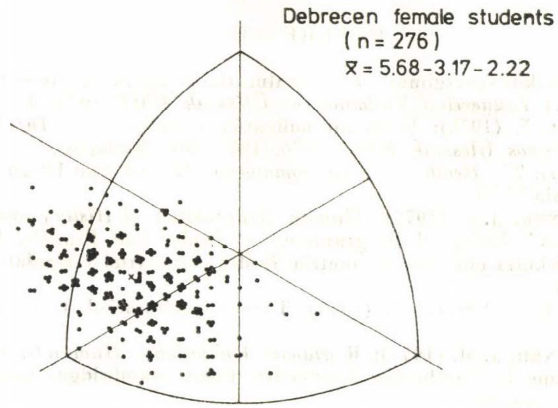


Fig. 5: **Somatotype of Debrecen female students**

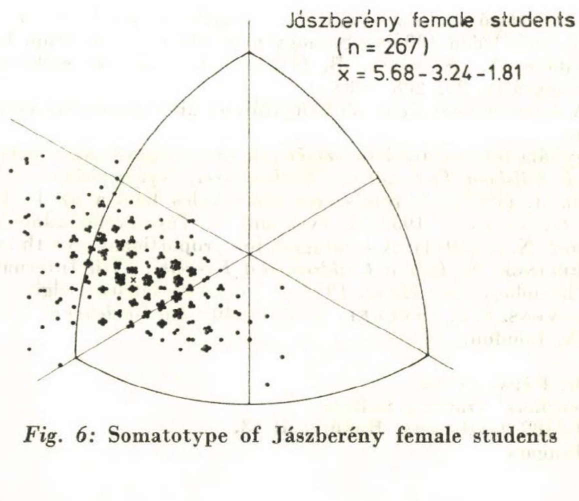


Fig. 6: **Somatotype of Jászberény female students**

The results of the surveys taken in Hungary (ABÁD 1976, FARMOSI 1976, EIBEN et al. 1974) indicate that the means of the somatotypes of the subgroups examined by the author surpass those of the other Hungarian college students in the first place in the Ist component, while, as regards the IInd component their mean is lower. This means that the female students of the Teachers' Colleges are "more fatty" and less muscular than the female university students of nearly identical age.

Summing up what has been set forth above: among subgroups by geographic regions of Hungarian female college students there are differences in body measurements, in body proportions and in components of the physique to be demonstrated. However, significant differences unambiguously only appear in the measurements of length. In other body measurements the variation among the subgroups is considerable, and it is difficult to demonstrate a tendency.

The differences are dimming, the effect of the improving environmental factors points toward further levelling-up.

REFERENCES

ABÁD, J. (1976): A ritmikus sportgimnasztika alkalmazhatósága az egyetemi testnevelésben. — *In:* PULAI, F. (Ed.) *Testnevelési Tudományos Ülésszak BME 1976.* 105—124. Budapest.

BARACS, F.—FARMOSI, I. (1976): Főiskolai hallgatók testalkata. — *In:* PULAI, F. (Ed.): *Testnevelési Tudományos Ülésszak BME 1976.* 197—204. Budapest.

CARTER, J. E. L. (1975): *The Heath — Carter Somatotype Method.* San Diego State University, San Diego, California.

COLLINS, K. J.—WEINER, J. S. (1977): *Human Adaptability. A History and Compendium of research.* International Biological Programme. — Taylor and Francis, London.

EIBEN, O. (1965): Főiskolás nők szomatometriai és dinamometriai vizsgálata. Testn. Sporteü. Szemle, *6;* 95—111.

EIBEN, O.—SÁNDOR, GY.—LÁSZLÓ, J. (1974): Turner-syndromások testalkata. — Anthrop. Közl. *18;* 41—48.

EVELETH, P. B.—TANNER, J. M. (1977): *Worldwide Variation in Human Growth.* International Biological Programme 8; Cambridge University Press, Cambridge, London, New York, Melbourne.

FARMOSI, I. (1976): Főiskolai hallgatónők testösszetétele és szomatotípusai. — *In:* PULAI, F. (Ed.): *Testnevelési Tudományos Ülésszak BME 1976.* 187—196.

KÁDÁR, P.—VÉLI, GY. (1971): A 18—20 éves férfilakosság testi fejlettsége. — Anthrop. Közl. *15;* 97—112.

— — (1974): Az akceleráció szakaszosságáról. — Anthrop. Közl. *18;* 105—111.

— — (1977): A szekuláris trend 100 éve Somogy megyében. — Anthrop. Közl. *21;* 93—100.

NEMESKÉRI, J.—JUHÁSZ, A.—SZABADY, B. (1977): Az 1973. évi sorköteles fiatalok testi fejlettsége. — Demográfia, *20;* 208—281.

RAJKAI, T. (1957): A debreceni egyetem női hallgatóinak antropometriai adatai. — Acta Univ. Debr. *4;* 257—265.

— (1965): A nyíregyházi felsőoktatási intézmények női hallgatóinak fejlettsége. — *A Nyíregyházi Tanárképző Főiskola Tudományos Közleményei,* Nyíregyháza.

RAJKAI, T.—JANCSÓ, J. (1955): A rendszeres testnevelés hatása az I—II. éves egyetemi hallgatóknál az 1952/53. és az 1953/54. években. — Testneveléstudomány, *1;* 129—146.

ROSS, W. D.—WILSON, N. C. (1974): A stratagem for proportional growth assessment. — *In:* BORMS, J.—HEBBELINCK, M. (Eds): *Children and Exercise.* VIth Internat. Symposium on Pediatric Work Physiology, den Haag, 1973. — Acta Pediatrica Belgica, Suppl. 169—182.

SHELDON, J. M.—STEVENS, S. S.—TUCKER, W. B. (1940): *The Varieties of Human Physique.* — Harper, New York, London.

Author's address: Dr. PÁPAI JÚLIA
Teachers' Training College
H-5102 Jászberény, Rákóczi út 53.
Hungary

Anthrop. Közl. *24;* 179–184. 1980.

CHANGES IN BODY COMPOSITION AND PHYSICAL WORKING CAPACITY AFTER A HIGH FIBRE DIET AND PHYSICAL TRAINING

by M. Peña, L. Barta, A. Regöly-Mérei, G. Simon
and É. Gedeon

(Higher Institute of Medical Science of Havana, Havana, Cuba; Ist Clinic of Pediatric's Semmelweis University Medical School, Budapest, Hungary; Szabadsághegy Children's Sanatorium, Budapest, Hungary)

Abstract. The changes in body composition and Physical Working Capacity (PWC) were studied in obese children, 7 to 14 years of age, under ward conditions during 4 weeks. They received a diet of 115 kJ per kg of body weight for the height with a crude fibre content of 12 grams per day, and underwent a controlled physical training. Before and after treatment, work test on a bicycle ergometer was performed with continous ECG recording, PWC_{170} and maximum oxygen uptake were calculated. Significant reductions in body weight and body fat—percentual and absolute — values were obtained ($p < 0.001$) after the treatment, as well as an evident increase in the PWC_{170} of the children. Although the maximum oxygen uptake remains unaltered in our patients when this variable was related to the amount of work performed, significant reductions were observed showing an improvement of their fitness and aerobic capacity.
Key words: obesity, fibre diet plus exercise, body composition, physical fitness.

Introduction

The therapeutic management of obese children is extremely complex and the results obtained have been quite disheartening. Reduction of energy intake in a magnitude that it should not disturb the period of growth and development, and to increase energy expenditure seem to be the most physiological procedure.

Recently several diseases including obesity have been ascribed to an overconsumption of sugar and fine milled starches, further to an underconsumption of crude fibre in the diet (Beyer and Flynn 1978). The authors' purpose was to use a high-fibre diet associated with a physical training program in order to study their effect upon body composition and physical fitness in a group of obese children.

Material and Methods

Fifteen obese children (8 girls and 7 boys), otherwise healthy, ranging from 7 to 14 years of age were studied under ward conditions during 4 weeks. At the time of admission each of them was subjected to the following examinations.

a) *Body composition*

Body weight and height with an accuracy of 0.1 kg and 1 mm, respectively, were recorded, and the per cent of the ideal weight referred to the height (IW/AH) was calculated. On the right side of the body, the skinfold thicknesses over triceps, biceps, subscapular, suprailiac, and calf were measured with a Holtain caliper at a standard pressure of 10 g/mm². From them the body fat percent was estimated by the prediction equation of PAŘÍZKOVÁ (PAŘÍZKOVÁ and ROTH 1972).

b) *Work test*

It was performed on a bicycle ergometer with continuous electrocardiographic recording for six minutes at increasing loads (1; 1.5; 2 watt|kg of body weight). The expired air was collected in a Douglas bag and its volume was measured with a dry gas meter. Gas samples were analysed for oxygen in a Godard rapox. The maximum oxygen uptake (VO_2 max) and its values referred to the lean body mass (LBM), and to the kilogrammetres of work performed were calculated.

Physical working capacity (PWC) was determined by plotting the heart rate against the workload per minute in watt units on graph paper. A straight line was drawn through three points making the best fit. The estimated amount of work that could produce a heart-rate of 170/min was considered PWC_{170}. This parameter was referred to the LBM.

c) *Treatment*

All patients were given a diet of 115 kJ/kg of ideal body weight for the height with a crude fibre content of 12 g per day approximately, using a Hungarian composition table.

The training program consisted in daily two sessions five times a week during a four-week period, following a fixed schedule. Each session lasted 20 minutes and started with an initial warming up by jogging. Thereafter followed a work load about 1.5 watt/kg during 10 minutes, determined individually for each patient depending on their ability. The exercise was finished with jogging gradually decreased up to relaxation.

After the treatment the same investigations as mentioned above were performed again. Student's t-test for paired series was used for statistical analysis (RADHAKRISHNA RAO 1966).

Results and Discussion

Figure 1 illustrates the variations in body weight and the IW/AH of the obese subjects after treatment, with a significant decrease of $p < 0.001$. Thus since, the changes in body weight certainly do not record the changes in body composition (LEUSINK 1972, PEÑA et al. 1979) the authors studied the variations of the body fat — in per cent and absolute values — and also found significant reductions ($p < 0.01$) (Fig. 2).

The authors observed, that in their cases, different individual responses to the treatment. They consider that the type of obesity — regarding the number

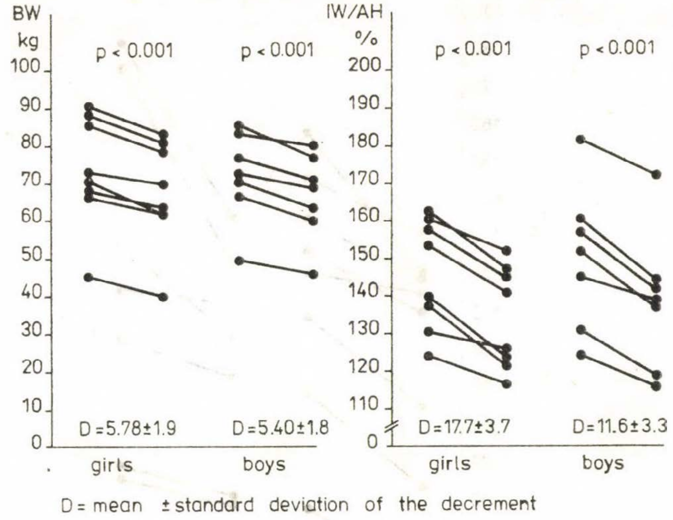


Fig. 1: **Changes in body weight and the IW/AH ratio during treatment**

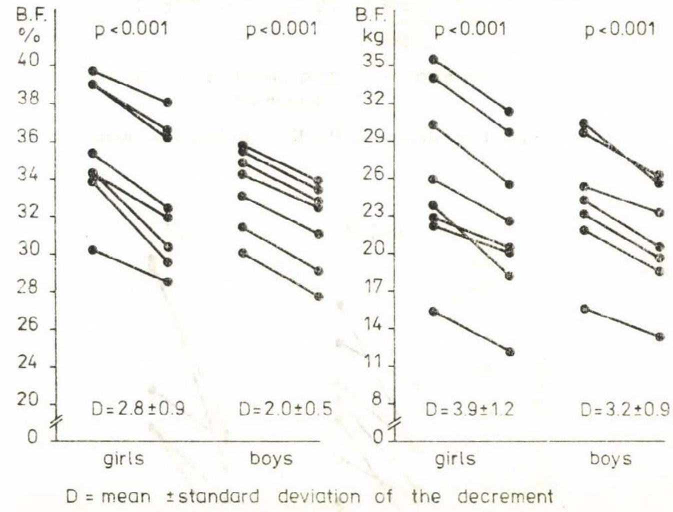


Fig. 2: **Changes in body fat during treatment**

of adiposites — plays an important role in these differences as has been stressed by Björntorp et al. 1977).

Significant increase in the PWC_{170} was observed after treatment, which was slightly higher in girls ($p < 0.01$) than in boys ($p < 0.05$) (Fig. 3). The sex difference could be ascribed to the fact, that the work performed by the girls was relatively harder than that done by the boys, considering to the different adaptability of vegetative functions (Pařízková 1977), as well as the difference in lean body mass proportion. Generally the larger LBM, the greater the work-

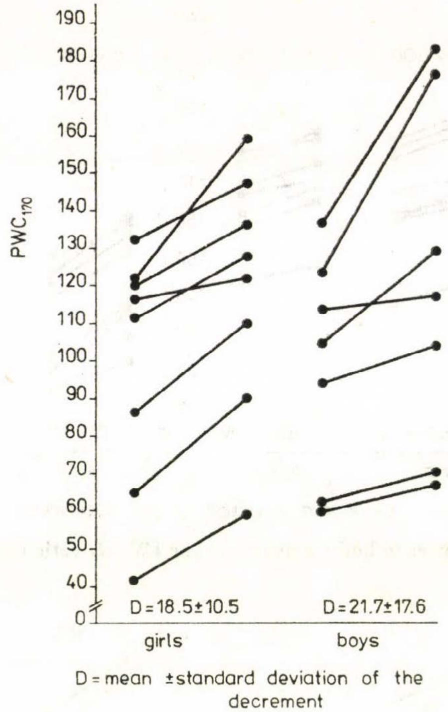


Fig. 3: **Changes in PWK_{170} during treatment**

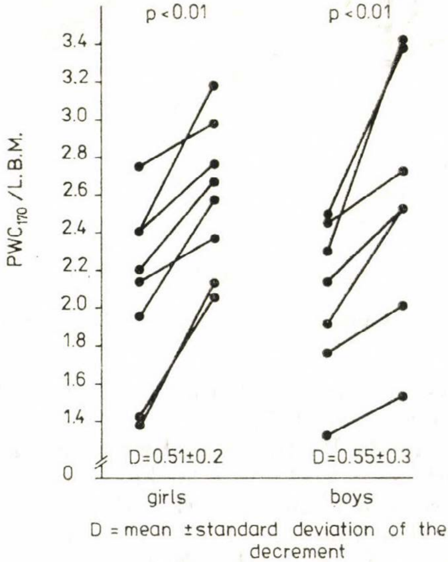


Fig. 4: **Changes in PWC_{170}/LBM ratio during treatment**

ing capacity — hence, the PWC_{170} was referred to the LBM and the increase in this ratio was also significant ($p < 0.01$), and the sex differences disappeared (Fig. 4).

The absolute values of $\dot{V}O_2$ max and those expressed per kg of LBM remained the same after the treatment; however, when related to the magnitude of work periformed, significant differences were seen ($p < 0.05$) (Fig. 5), reflecting an improvement of their fitness and aerobic capacity. Our results are in harmony with those reported by PAŘÍZKOVÁ (1977), and, as she stated, two factors are involved here: progressive adaptation to increased activity and the reduction of weight which are dynamically interrelated and form an integral part of the adaptation consequence of increased muscular work. These findings suggest that a formal exercise program associated to a reduction of energy intake may complete dietary intervention in the treatment of obesity.

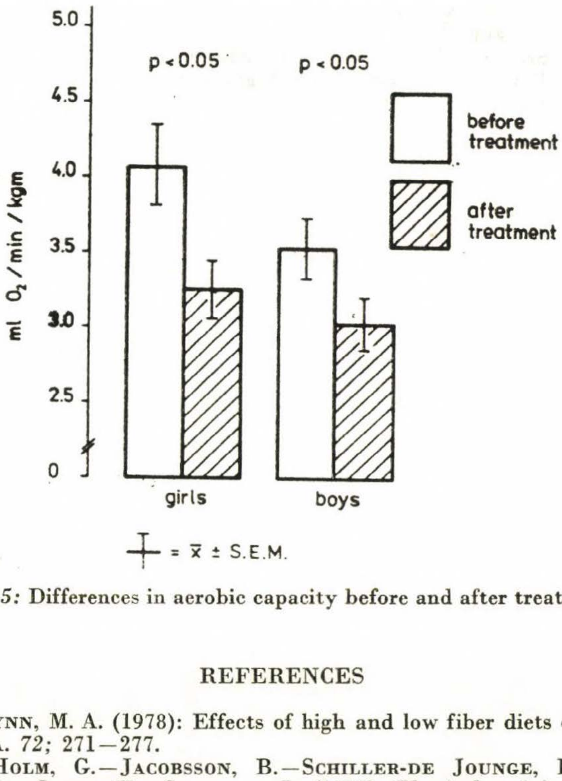


Fig. 5: Differences in aerobic capacity before and after treatment

REFERENCES

BEYER, P. L.—FLYNN, M. A. (1978): Effects of high and low fiber diets on human feces. — J. Am. Dietet. A. *72;* 271—277.

BJÖRNTORP, P.—HOLM, G.—JACOBSSON, B.—SCHILLER-DE JOUNGE, K.—LUNDBERG, P. A.—SJÖSTRÖM, L.—SMITH, U.—SULLIVAN, L. (1977): Physical training in human hyperplastic obesity. IV. Effects on the hormonal status. — Metabolism, *26;* 319—328.

LEUSINK, J. A. (1972): Body composition, glucose and nonesterified fatty acids during exercise in periods of training and out of training.—*In:* "*Nutritional Aspects of Physical Performance*" Nutricia Symp. Papendal 1971. Ed. Nutricia (pp. 100—116). Mouton Comp. The Hague, Netherlands.

PAŘÍZKOVÁ, J. (1977): *Body Fat and Physical Fitness.*—Martinus Nijhoff B. V. Medical division, The Hague.

PAŘÍZKOVÁ, J.—ROTH, Z. (1972): The assessment of depot fat in children from skinfold thickness measurements by Holtain (Tanner/Whitehouse) Caliper. — Human Biol. *44;* 613—620.

PEÑA, M.—BARTA, L.—REGÖLY-MÉREI, A.—TICHY, M. (1979): Some anthropometrical considerations of obese children in pediatric practice. — Acta paediat. Acad. Sci. hung. *20*; 333—341.

RADHAKRISHNA RAO, C. (1966): *Advanced statistical methods in biometric research.* — John Wiley Sons, New York. pp. 92—102.

Authors' addresses: Dr. MANUEL PEÑA
Higher Institute of Medical Sciences of Havana Ave 31 y Calle 146
Havana
Cuba

Prof. Dr. BARTA LAJOS
Dr. REGÖLY MÉREI ANDREA
Ist Clinic of Paediatrics, Semmelweis University Medical School
H-1083 Budapest, Bókay J. u. 53.
Hungary

Dr. SIMON GYÖRGY
GEDEON ÉVA
Szabadsághegy Children's Sanatorium
H-1121 Budapest, Mártonhegyi út 6.
Hungary

Anthrop. Közl. *24;* 185—188. 1980.

THE IMPORTANCE OF RADIAL METAPHYSEAL BAND WIDTH

by F. PÉTER, A. TAR and I. SZÉCSÉNYI-NAGY

(Buda Children's Hospital and Polyclinic, Budapest, Hungary)

Abstract. A radiodense metaphyseal band of diverse width is present at the distal end of the radius in children. The individual growth rates in stature cannot be accurately predicted from the width of this band but the mean width is related to the velocity of growth in stature.

Of sixty-five children roentgenograms of the wrist were taken (152 rtg) and stature was measured at an examination with endocrine disorders, before and after Human Growth Hormone (HGH), thyroid or anabolic steroids therapy. The diagnosis of the children in this study was hypothyroidism, Graves disease, short stature with or without GH deficiency.

The tight metaphyseal band was much larger after thyroid treatment in hypothyroidism, but occasionally its width was definitely more considerable, with a rapid growth rate in Graves disease. The radiodense band was tight in short stature with or without GH deficiency, too; it was much larger also after HGH or anabolic steroid therapy.

In these clinical conditions the band width may be a new guide as to whether or not the child is growing normally.

Key words: radial metaphyseal band width, dwardism, anabolic steroid.

Introduction

EDLIN, WHITEHOUSE and TANNER (1976) took semi-annual measurements of the width of relative radiodensity at the distal metaphysis of the radius in 32 girls and 35 boys, and compared these wrist roentgenograms (1330 roentgenograms in all) with the growth rate values, taking the mean for the same age-group as a basis for comparison. They found that the width of the relatively radiodense metaphyseal band showed a close correlation with the growth-rate. This is a conclusion valid for the mean of the group. At the end of their report they mention that in the roentgenograms the band was always narrower in children with a deficiency of growth hormone (GH) and in hypothyroidism. They also mention that in substitutional treatment of one hypothyroid child and one with GH deficiency the band became significantly wider in parallel to the velocity of the increase in stature.

The aim of the present study was to examine the radial bands of children with growth disturbances as a function of the hormone situation and the treatment parameters.

Material and Method

Bone age was determined in the standard way (TANNER, WHITEHOUSE, HEALY and GOLDSTEIN, 1972) using wrist roentgenograms taken at a distance of 1 m and by means of a precision caliper to measure the width of the most distal compact layer of the radius with an accuracy of 0.1 mm. The authors divided the 162 roentgenograms taken of 72 children into the following groups:
(1) the values of children being treated for hypothyroidism,
(2) the values of untreated children with Graves disease,
(3) the values of dwarf children without or during Human Growth Hormone (HGH) and anabolic steroid treatment. In addition, we introduced wrist roentgenograms of 18 girls under the age of three (who had proved to be healthy) since the TANNER's group only gave normal values for girls from the age of four.

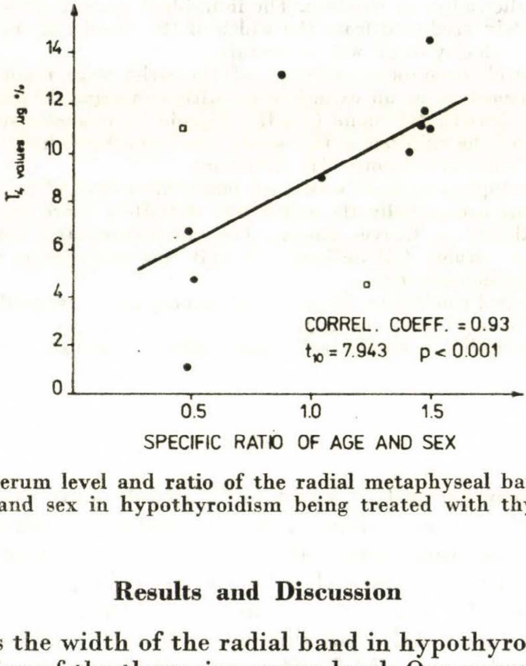


Fig. 1: Thyroxine serum level and ratio of the radial metaphyseal band's width specific to age and sex in hypothyroidism being treated with thyroid

Results and Discussion

Figure 1 shows the width of the radial band in hypothyroidism under treatment, as a function of the thyroxine serum level. One parameter of the figure is the absolute value of the thyroxine, while the other is the value ratio of the width of the radial band specific to age and sex. (The authors saw it possible to consider the normal values for the different ages and sexes by dividing the value measured with the normal mean for children of the same age and sex). The two series of values show a close correlation (correlation coefficient = 0.93). As it appears from the dispersion round the regression line, the correlation is very strongly significant ($p < 0.001$).

Two of the 12 individual values should be stressed, for they demonstrate that in certain cases the band may be comparatively wide despite a low thyroxine value and vice versa.

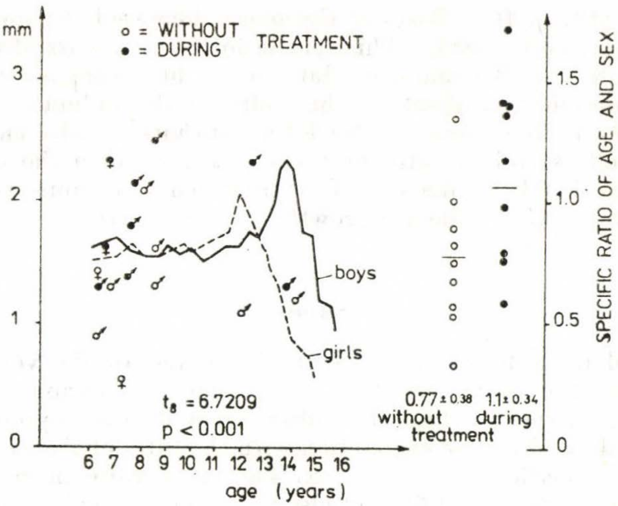


Fig. 2: **Radial metaphyseal band width and his specific ratio to age and sex in dwarfism without and during treatment with anabolic steroid**

Therefore, when examining the untreated cases of Graves' disease, the authors had counted on a wider than average radial band. The mean of seven untreated patients suffering from Graves disease with bone ages under 14 was truly high (1.25), but also standard deviation was quite high: ± 0.676. In the case of 10 patients with Graves disease the evaluation of the roentgenograms was made more difficult by the fact that almost without exception their bone ages were significantly higher than their biological ages, and at a bone age of 14—15 years we found, as in TANNER's group, that the band width could hardly, if at all, be evaluated. In the case of 27 dwarfs with age and sex specific ratios of 0.645 and a standard deviation of ± 0.267, there was only a single case where the ratio exceeded 1. A number of patients of this group received combined hormone treatment, some received only HGH therapy and there the width of layer grew in every single case.

Figure 2 shows the values of layer thickness for 9 children treated for dwarfism with anabolic steroid (in amounts of 1—2 mg per kg a month) without and during treatment. We have also shown (on the right hand side of the Figure) the values of the age and sex specific ratio, their mean and standard deviation. The difference is very strongly significant ($t_8 = 6.721$, $p < 0.001$).

The authors used the factors noted and published by EDLIN et al. (1976) together with the one-case studies they presented for each of the two hormone treatments (HGH and thyroxine), for examining the correlation in a larger population. They found that there was a very strongly significant correlation between thyroxine and the relatively radiodense band width in the treated hypothyroid group. Since it appears that, in general, the increasing width of the band is related to growth and not to any hormone, they assume that somatomedins must have a direct role in the mechanism of the effect. This assumption is supported by the experiments on animals published by HOLDER and WALLIS (1977). Here doses of thyroxine increased the somatomedin level in a Snell dwarf mouse strain. This correlation is even more obvious in the case of HGH treatment. We found no data in the literature indicating the effect of anabolic steroid treatment on the width of the radiodense band or as to what happens to the somatomedin level. Authors' results clearly show that during anabolic steroid treatment there is a growth in the thickness of the band, just as in thyroxine or HGH treatment. Authors assume that the anabolic steroids also influence growth, at least partly, through the somatomedins.

Summary

The radial metaphyseal band width is related to the velocity of stature growth, according to EDLIN et al. In the authors' examinations describing in the present paper, in hypothyroidism treated with thyroid the thyroxine serum level showed a close correlation with the ratio of the radial metaphyseal band width, specific to age and sex. The mean ratio in cases of untreated Graves disease was high (1.25) but also the standard deviation was quite large. In dwarfism the authors found very narrow band width; the mean value of age and sex specific ratios was 0.645. The increase of band width during anabolic steroid treatment was very strongly significant. On the basis of literature data and own experiences the authors assume a role of somatomedins in the action mechanism of thyroxine and anabolic steroid, besides HGH.

REFERENCES

EDLIN, J. C.—WHITEHOUSE, R. H.—TANNER, J. M. (1976): Relationship of Radial Metaphyseal Band Width to Stature Velocity. — Am. J. Dis. Child. *130;* 160—163.

HOLDER, A. T.—WALLIS, M. (1977): Actions of GH, Prolactin and Thyroxine on Serum Somatomedin Like Activity and Growth in Hypopituitary Dwarf Mice. — J. Endocrin. *74;* 223—229.

TANNER, J. M.—WHITEHOUSE, R. H.—HEALY, M. J. R.—GOLDSTEIN, H. (1972): *Standards for Skeletal Age.* — Centre International de l'Enfance, Paris.

Authors' address: Dr. PÉTER FERENC
Dr. TAR ATTILA
Dr. SZÉCSÉNYI-NAGY ISTVÁN
Buda Children's Hospital and Polyclinic
P. O. Box
H-1277 Budapest
Hungary

Anthrop. Közl. *24;* 189—194. 1980

CONTRIBUTION TO THE GENESIS OF OBESITY FROM THE ASPECT OF EXERCISE AND NUTRITION DURING GROWTH AND DEVELOPMENT

by M. PROKOPEC

(Institute of Hygiene and Epidemiology, Prague, Czechoslovakia)

Abstract. The parental influence on the physical and mental development of their children can be positive as well as negative. While, apart from the choice of partner, parents cannot influence the set of genes they impart to the next generation, they do have an influence on the positive development of their children by creating favourable ecological conditions the quality of which increases with education and with the recognition and development of the child's talents. Love and care alone without the necessary education may have a negative effect (rise of obesity, etc.). Education of the parents acts as a positive factor on the child's mean height, it has a positive correlation with the per capitum income in the family, with the number of inhabitants in the place of living, and a negative correlation with the number of children in the family.

A series of examples of favourable and undesirable impact of famiiy on the child's physical development, given in the paper, were derived from a longitudinal follow-up from birth to maturity of a group of 300 Prague children.

Key words: genesis of obesity, exercise, nutrition, growth and development, Prague children.

Introduction

Essentially the influence of the parents on the physical and mental development of their children is twofold. On the one hand, they pass on a set of hereditary characteristics and endowments in the form of genome and, on the other hand, they create the ecological conditions in which the child is reared, protect it from adverse factors, ensure adequate stimuli for its physical and mental development, select the child's activities and support those which promote its talent best. Whereas in the first case the active part of parents is manifested only in the choice of the partner, in the second case the influence of parents (and of grandparents) is absolute within the given social conditions. The role of parenthood, as outlined above, clearly indicates the need for judgment and knowledge which under normal conditions parents can acquire only by active preparation. Grandparents, too, exercise a considerable influence on the development of children.

The author do not mean to go into details and to solve the problem in its entirety. He merely wishes to draw attention to the responsible tasks of parents for the child's healthy development and for its later role in social life.

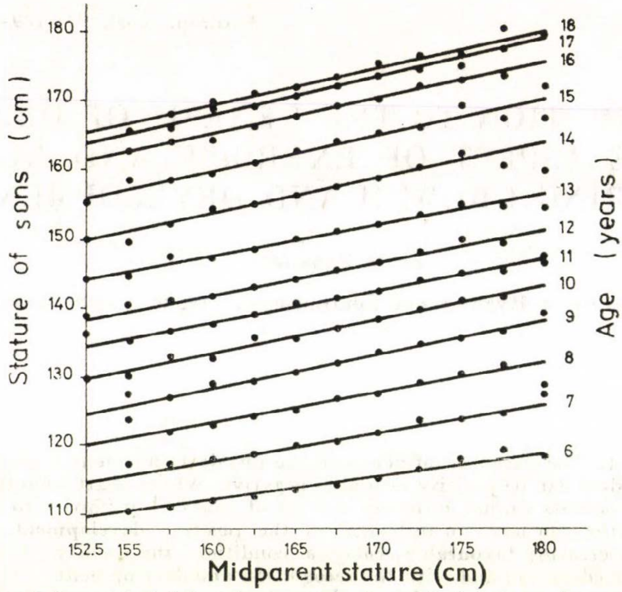


Fig. 1: **Relations of the mean height of parents to the son's height at the age of 6 to 18 years (Orig. M. Prokopec)**

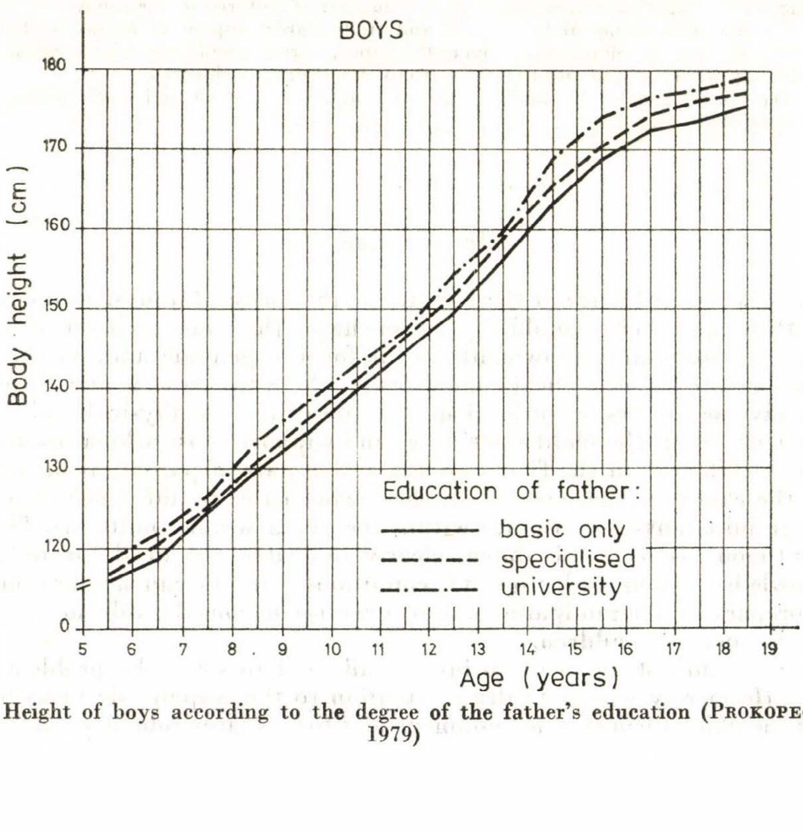


Fig. 2: **Height of boys according to the degree of the father's education (Prokopec et al. 1979)**

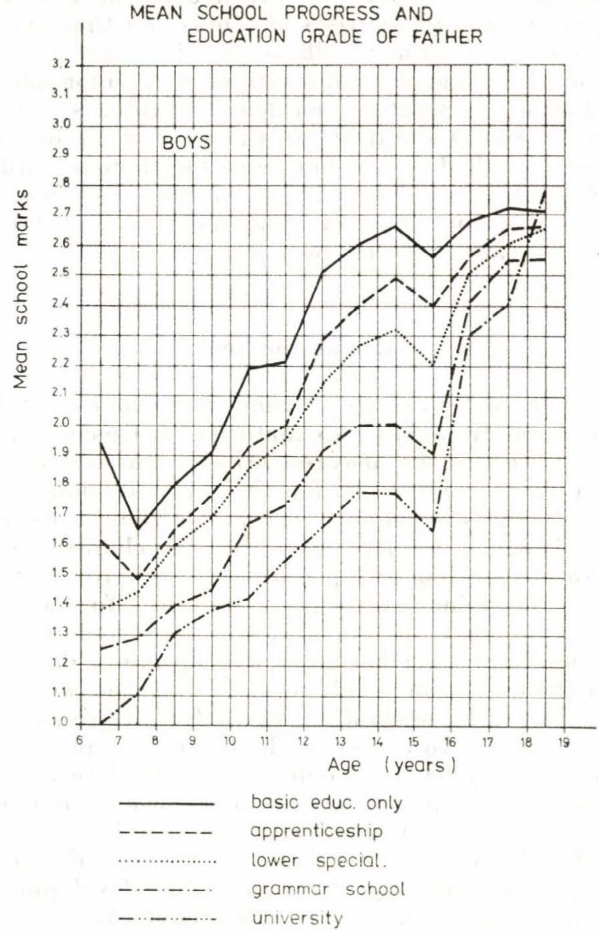


Fig. 3: **School marks of the boys according to the father's education (Prokopec et al. 1979)**

The ecological influence of parents rests on securing healthy living, feeding, regimen of day, on a systematic development of mental faculties and positive character traits.

At the analysis of the results of three nation-wide investigations of youth in Czechoslovakia (Prokopec et al. 1979) there repeatedly was found a positive correlation between the parents' education level and the body height of their children. There was a positive relation between the parents' and children's body height. If we added the school marks to these characteristics, we found a significant correlation between the degree of the parents' education and the school reports of the children, especially in elementary schools. The circle was closed if to the parents' education, to their mean height a higher income per head in the family, a greater number of citizens in the place of living, a smaller number of children in the family and a lower order of the child's birth in the family were added (Figures 1, 2, 3).

The enlightenment of the parents is reflected in the child's development insofar as it is less exposed to the risks of illness and that, on the whole, its living conditions are better. From childhood on it is taught hygienic principles, care is bestowed upon the quality and length of sleep, upon adequate clothing and upon the adequacy of whatever burden. The child is taught endurance, a positive attitude to sports and fresh air, the onset of an illness is recognised in time and the doctor called in. The food corresponds to scientific knowledge, to the child's age and physical exertion; a higher salary usually associated with higher education permits healthy living and a stimulating environment. Obviously the above characteristics do not apply in every case.

Analyzing methods

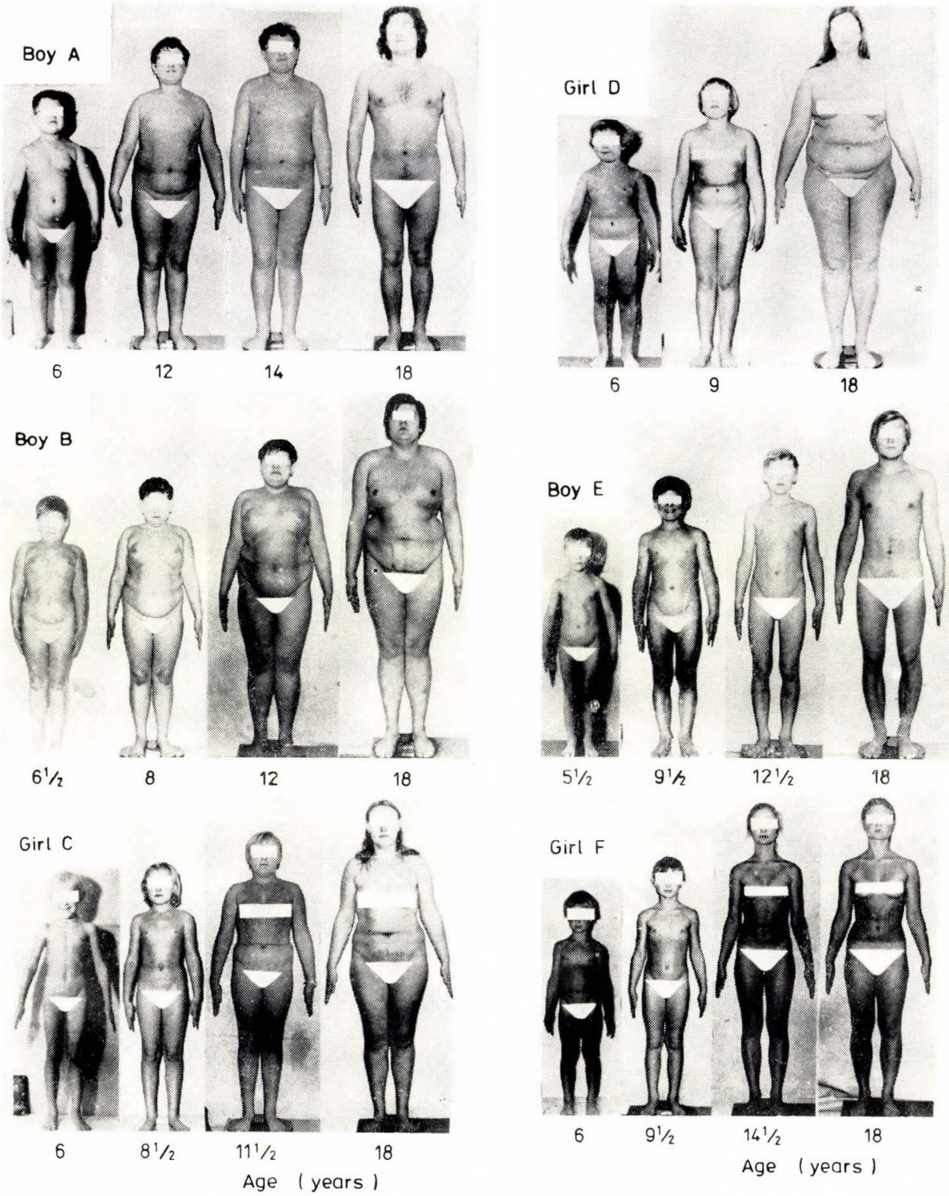
In 1956 we started our first study on the somatic and mental development of a group of children from birth to maturity in Czechoslovakia (Kaplan et al. 1969). In contrast to the above-mentioned cross-sectional studies performed always at 10 year intervals, for this investigation we selected 300 children from the Prague district 3 at random. Although we were primarily interested in the biological development of healthy children, in the course of years of systematic cooperation with parents, we discovered that it was possible for investigators to determine in retrospect, from the information accumulated in the field of morphology, psychology, sociology and the child's health status, the preconditions for a harmonic and optimum development of the individual. With the exception of advisory medical care we did not interfere with the development of these children. The oldest in this investigated group is now 23, and the youngest 18 years old. The original number of the individuals followed up systematically has been reduced to 180. Almost 30 of these bring along their own children, starting thus the study of a second generation.

The results of the two investigation methods complement each other. The influence of the family is most intensive until the age of three years. After the child's entry to school its impact on the child's development reduces the influence of parents. From puberty onwards (about the age of 12 years) the influence of children collectives, out-of-school and out-of-family influences (reading, cinema, television, theatre, chance aquaintances, sports and persons in the neighbourhood) gain the upperhand. However, parents should still retain control of these influences, their analysis and guidance.

Results: Case studies

We shall show on a few examples the positive and unconsciously negative effect of parental care on the somatic development of their children. In a similar way parents can influence the psychic development of the child and its future life.

(1) The boy A had a visual defect from birth which led to lesser motor activity. Due to the exaggerated parental care the boy developed overweight which probably would have increased if he had not been isolated from this influence by entering a school for trainees. There he joined a group going in for


Boy A
6 12 14 18
Girl D
6 9 18
Boy B
6½ 8 12 18
Boy E
5½ 9½ 12½ 18
Girl C
6 8½ 11½ 18
Age (years)
Girl F
6 9½ 14½ 18
Age (years)

yoga and in the course of three years he corrected his somatotype through exercise and an adequate diet (Plate I, A).

(2) The unconsciously negative effect of parents (in the form of exaggerated care and excessive feeding) manifested itself in the boy B who at the age of 3 years showed no signs of obesity. Continual overfeeding together with a greater appetite and only little exercise contributed to the syndrome of obesity. Parental influence was not interrupted, and at the age of 19 years B is still obese trying hard to lose weight (Plate I, B).

(3) At the age of 6 years the girl C was tall for her age with adequate proportions and with rather an inclination to slimness. At the age of 8 she started to gain in weight, from the age of 11 she was overweight in relation to age and height. At the age of 22 years she has already 3 children (Plate I, C).

(4) The girl D due to excessive feeding (too much care in the family, especially on the part of the grandmother) was already at the age of 6 years overweight, being tall for her age. In the given environment she could not cope with her growing obesity, especially since her parents made her choose the vocation of cook because of her preference for cooking and food. Only when she met her boyfriend did she make a great effort to reduce weight. In this she succeeded with the help of clinical care. Today she is married and has one child (Plate I. D).

(5) A positive influence was exercised by parents on the somatic development of the boy E by evoking and supporting his interest in sports (swimming, water polo). His physical condition and discipline serve him well in his present occupation. He is married with one child (Plate I. E).

(6) The parents of the girl F (father an active sportsman) encouraged from the earliest childhood a love for exercise. This interest led her to professional dancing, representing her country also abroad (Plate I. F).

One cannot perform experiments on humans. The development of the individual cannot be repeated. Neither is it possible to separate the number of influences affecting it. Nonetheless, the above examples have demonstrated the purposeful influence of parents in the case of the talented girl and on her career, and the uncritical attitude of parents to motor activities and nourishment of their children with a tendency to obesity. In cases 1 to 4 a tendency to overweight is in the family. Garn et al. (1978) and also others have shown that life in a family where the parents are overweight creates the risk of obesity in children (even in adopted children and other members living in the family).

Before World War II obesity was to a certain degree a sign of prosperity and of a good social position in Czechoslovakia. The farmer had to be fatter than the farmhand, the factory owner or foreman fatter than the worker. Today, when every workman can overeat if he wants to at least with staple food, and when the harm of excessive overweight is generally known, obesity is rather a manifestation of lack of dietary discipline and aversion to physical exercise. In contrast, adequate slimness based on a correct diet (proper composition, rich in protective substances, etc.) and elasticity are the signs of intelligence. This holds not only for parents but also for the children.

Conclusion

The parents' influence to the somatic and mental development of their child may be positive as well as negative. Whereas, apart from the choice of partner, the parents cannot influence the set of genes passed on to the next generation, they can exert an influence on the positive development of their child by creating adequate ecological conditions, the quality of which increases with education and by recognizing and developing the child's skill. Love and care alone, without concomitant enlightenment, may also have a negative effect (obesity, etc.). The education of the parents acts as a positive factor on the child's mean height, it positively correlates with per capita income in the family, with the number of citizens in the living place and has a negative relation to the number of children in the family.

Science can furnish concrete information for the required rearing of children. Introduction of this knowledge into practice is no less important than scientific investigation itself.

REFERENCES

PROKOPEC, M.—TITLBACHOVÁ, S.—ZLÁMALOVÁ, H.—PADEVĚTOVÁ, D. (1979): Odraz životního prostředí na tělesný a dusevní vývoj mládeže. — Čs. hygiena, *24;* 280—300.

KAPALÍN, V.—KOTÁSKOVÁ, J.—PROKOPEC, M. (1969): *Tělesný a duševní vývoj současné generace našich dětí.* — Academia, Praha.

GARN, S.—BAILEY, S.—COLE, P.—HIGGINS, I. T. T. (1978): Evidence for the social inheritance of obesity in childhood and adolescence. — *In:* GEDDA, L.—PARISI, P. (Eds): *Auxology: Human Growth in Health and Disorder.* 217—223. — Academic Press, London, New York, San Francisco.

Author's address: Dr. MIROSLAV PROKOPEC
Institute of Hygiene and Epidemiology
Praha, Šrobárova 48.
Czechoslovakia

Anthrop. Közl. *24;* 195–208. 1980.

THE BIOPSYCHOLOGY OF AUTISTIC AND NORMAL CHILDREN

by V. REYNOLDS

(Department of Biological Anthropology, Oxford University, Oxford, England)

Abstract. A three-year-study was made of autistic and normal children. Behaviour was studied using ethological methods. Endocrine physiology was studied by measuring catecholamine excretion rates. Clear differences in behaviour were found between the two groups. Endocrine differences did not correlate with behaviour differences at the group level, but did so at the individual level. Findings suggest that behaviour functions to stabilise physiological systems within normal tolerance limits. The implications of this approach for the understanding of the biopsychology of stress are discussed.

Key words: biopsychology, behaviour, endocrine differences, catecholamine excretion rate, normal children, autistic children.

Introduction

In this necessarily short paper the author wants to do three things. First to describe some of the studies carried out by his department in the field of catecholamines and behaviour. Second to focus on one study in which a co-worker, H. HELEVUO and he were especially involved concerning normal and autistic children. And third to try and sketch a theoretical model based on the research they have done to show how behaviour may relate to underlying physiological processes.

But first, the author should like to introduce the subject of catecholamines and behaviour as a whole. Catecholamines, notably adrenaline* and noradrenaline* but also their metabolites, can be studied in the serum or the urine, and additionally noradrenaline can be studied in the CNS where it is a plentiful neurotransmitter. All our studies have been on urinary catecholamines. There are good reasons for this. We have not wanted in particular to investigate CNS (neuro-) physiology in relation to behaviour. Such studies are extensively pursued elsewhere and present many problems of their own. As regards the question: "blood or urine?", we are seeking for a measure of *secretion* rates (from the adrenal medulla) in our studies, but although this would seem to favour taking measurements from the bloodstream we have not in fact done so, preferring urinary *excretion* rates for a number of reasons. Primarily, especially with children, it is upsetting for them to be subject to blood testing proce-

*The term adrenaline is synonymous with epinephrine, noradrenaline is synonymous with norepinephrine etc.

dures, let alone to having an indwelling catheter or anything like that. Second, it is not in fact permitted to take blood samples from children for non-medical reasons and we could be technically committing an assault on children if we did so. Third, we wanted the situations under study to be as natural as possible, because our interests are mainly in the *normal* physiology of behaviour. The reason for including samples of autistic children in the work was to try and shed light on the normal ones by including an abnormal group for comparison. The question does arise, however, whether urinary catecholamine levels are comparable to blood levels, or how the two are related. In theory, it could be argued that the two levels might vary quite differently so let us look at this matter. We can distinguish three possibilities: first that if blood levels are high, urinary levels would be low. Thus it could be argued that if the body's needs for adrenaline are great, there will be a high rate of secretion into the bloodstream, but owing to a high rate of take-up, use and breakdown excreted levels would be low. The opposite could also be argued: that a high secretion rate would be reflected in a high excretion rate. Lastly it could be argued that there can be no clear relation between the two because of the complexity of the metabolic processes involved.

Our studies have been based on the second assumption, which underlies previous work in the field in the USA and in Sweden. But we have not just made the assumption. We have attempted to establish the facts by measuring not just urinary adrenaline and noradrenaline, but also their chief metabolites, metadrenaline, normetadrenaline and vanil-mandelic acid (VMA). We have found that levels of these metabolites co-vary with the levels of the primary catecholamines in the urine, i.e. where one is high all are high, and vice versa. This we have interpreted to mean that a high excreted level does indeed indicate a high secreted level since otherwise we could expect to find a higher or lower relative level of metabolites to primary catecholamines depending on the extent of body take up of the initial secretions. Our findings also indicate that measurements of urinary adrenaline and noradrenaline alone are enough to indicate secretion levels since the measurement of the metabolites does not add extra information about secretion levels (besides being time-consuming and rather difficult).

A second line of evidence indicating that urinary catecholamine levels are an accurate indicator of secretion levels relates to their functional significance in general. The early work of CANNON (1953) in particular indicated that adrenaline was secreted by the adrenal medulla at times of emotional arousal and he suggested that it was a hormone functioning to enrich the content of the blood by liberating into it stored glygogen and other substances useful for the efficient functioning of central body organs and muscular tissue at times of 'fight or flight', e.g. in emergency situations. It thus acts as a back-up system prolonging the immediate effects of the sympathetic nervous system which provides an initial boost and, in fact, activates the adrenal medulla itself via the splanchnic nerve, contracting it to discharge its contents into the adrenal vein.

Because CANNON's hypothesis has received support ever since and been amplified in various ways, adrenaline, and to some extent noradrenaline, too, have often been called 'stress hormones' and it is for this reason that we have focussed on them in our research. There are other 'stress hormones', notably the adrenal cortico-steroids produced by the adrenal cortex, but these are slower acting and less sensitive measures of emotional experience than adrenaline. Finally, to round off these introductory remarks, we should note that in the last decade or so it has become increasingly possible to make very accurate estimations of the quantity of adrenaline and noradrenaline present in samples, and we have used the most accurate method available at the time of study, namely spectrofluorometry, a technique based on the fluorescent property of adrenaline and noradrenaline in suitably prepared samples coupled with a chart recorder. Full details of the method used can be found in Dr. HELEVUO's thesis (1978), available at the Bodleian Library, Oxford.

Other studies

Brief mention will now be made of other relevant studies made elsewhere, and in our own department.

Elsewhere, catecholamine studies have mainly been made in the USA and Sweden, but there have been some in Britain, too. For the most part, people have been studied in situations where there is a clear element of psychological stress and their catecholamine levels have been compared before, during and after a so-called 'stress' period. For example studies have been made of free-fall parachutists, people undergoing dental treatment, people watching various kinds of films, racing drivers, ordinary drivers, trawlermen working in difficult conditions, children undergoing mathematical tests, train commuters on crowded trains, and sawmill workers in repetitive, noisy working conditions. Such studies all add up to a picture of increased catecholamine output in stressful conditions (see MASON 1968, LEVI 1971).

We should note, however, that while the environmental factors have been well described and the catecholamine levels accurately measured the actual behaviour accompanying the stressful situations has not normally been described in any systematic way. By using the methods of description of ethology we have brought far more accuracy to the behavioural side of the study in our work on children.

Besides the study of children which will be described next, we have at Oxford made a further series of studies, some small-scale, others larger. Each method (small, individual and large, population studies) contributes in different ways, as will be clear later in this paper.

On the individual side we have collected data on a percussionist in a rock band, lecturers in our department delivering lectures and seminars, and students performing at examinations. Longer-term studies have included 24-hour and one 2-week study of individuals, thus giving data on circadian rhythms as well as times of stress. These longer studies also involve a diary of events kept by the subject. In recent studies we have added data on heart rate, respiratory rate and skin resistance to the catecholamine data, using a Medilog ambulatory monitoring device for the heart rate data. Finally, we are currently engaged in a large-scale study of the health and life-style of the adult populations of a number of villages to the north of Oxford, and have collected urine samples from these people and begun to relate their catecholamine levels to aspects of their life-styles such as occupation.

The study of children

This study consisted of observations of two types of children, normal and autistic, to compare their behaviour and see if there were any correlations between their behaviour and their catecholamine excretion rates. The autistic group was included because it has been suggested, notably by the TINBERGENS (1972), RICHER (1976) and others, that they are under stress. Would they, then, show an unduly high level of catecholamines?

We did the study twice over, once on a sample of 10 normal children aged 5—6 years at a primary school, and 4 slightly older autistic children attending a hospital school (Table 1).

Table 1

Age, sex and weight of children in the first sample

Child	Normal or autistic	Sex	Age (months)	Wt (kg)
Anna	normal	F	68	19
Christine	normal	F	68	20
Helen	normal	F	68	23
Laura	normal	F	67	22
Linda	normal	F	65	33
Andrew	normal	M	67	20
Alex	normal	M	66	20
Michael	normal	M	62	18
Peter	normal	M	70	23
Tom	normal	M	63	19
Darrell	autistic	M	118	28
Henry	autistic	M	112	28
Ken	autistic	M	88	19
Sam	autistic	M	93	24

Behaviour was recorded by an observer (H. HELEVUO) in the room with the children, who were observed in a randomised order which nevertheless was adjusted so that each child had the same total observation time. Normals were observed over a total of 6 mornings, autists could only be observed on 5 occasions and these were afternoons. A checksheet system was used, behaviour being recorded in the form of occurrence or non-occurrence of specified *units* of behaviour during the period concerned. The units are shown in Table 2 together with a set of *categories* into which the units were grouped for the sake of later analysis and comparisons. Note the 'Locomotion' categories in this table. These were included because noradrenaline levels in particular are known to vary according to the extent of locomotor activity, and we, therefore, needed this information in order to interpret noradrenaline findings. The other categories are mainly descriptive or motivational, and are based on earlier work by myself and others on children's behaviour.

Regarding the urine collection procedure, bladders were emptied for all children before the observation period and again afterwards. The first time the urine was discarded, the second time it was saved, and aliquots prepared and frozen for subsequent analysis. Finally, a series of overnight (i.e. first

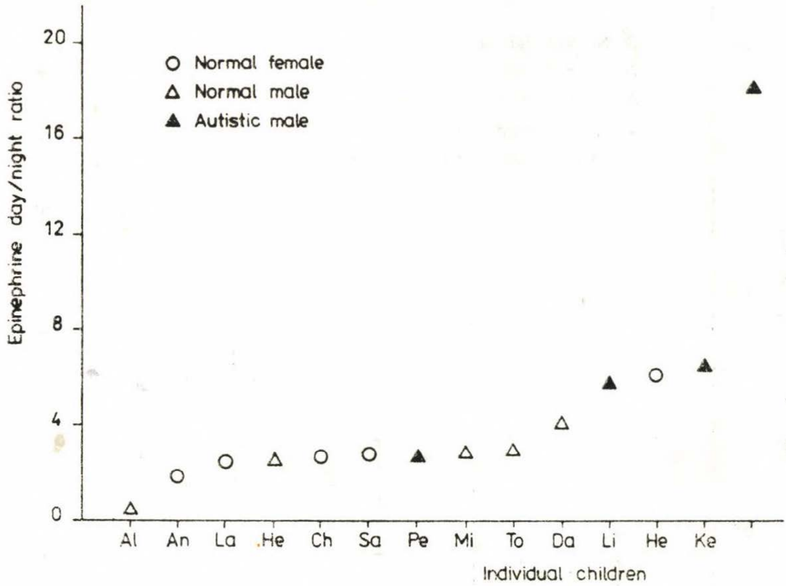


Fig. 1: **Ratio of mean daytime epinephrine excretion rates to night-time excretion rates, first sample. Normal mean 2.9, autistic mean 8.3. *t* test, 2.55, $P < 0.05$**

urination in the morning) samples was obtained for each child (with parental help) for comparison with the daytime samples.

The results of the first year's work (sample of children just described) were as follows. Taking the catecholamines first, the clearest results were for adrenaline, where there was a significant finding that autists were excreting more adrenaline than normals in relation to overnight levels (Fig. 1).

In fact, autistic children seemed to have unusually low overnight levels. However, the sample size was too small for generalisation, and we realised the need for a larger study to confirm or reject this finding. The adrenaline results are shown in Figure 2.

Regarding behaviour, the clearest difference was, as expected, in solo behaviour (Fig. 3). As the figure shows, the two groups were wholly separate for these kinds of solitary activity. Note that the high levels of solo behaviour indicate that autistic children are not inactive; on the contrary they are doing things but the things they do are not social. It goes without saying that their scores on 'positive' or 'friendly' social behaviour are lower than those of normal children, as Fig. 4 (Initiate Associative) shows. Some individual autists did, however, show occasional outbursts of very aggressive behaviour.

We analysed the relation between behaviour and catecholamines for all the children, normal and autistic, together. This showed a number of correlations, as shown in the Table 3. Most of the correlations arose, as can be seen, when day/night ratios were used rather than daytime levels. Part of the reason for this is doubtless the extent of individual variability in actual levels of catecholamine 'arousal'. As was seen in the overall adrenaline results, intra-individual variance was considerably less than inter-individual variance, i.e. the children showed day-to-day constancy in their catecholamine levels. This

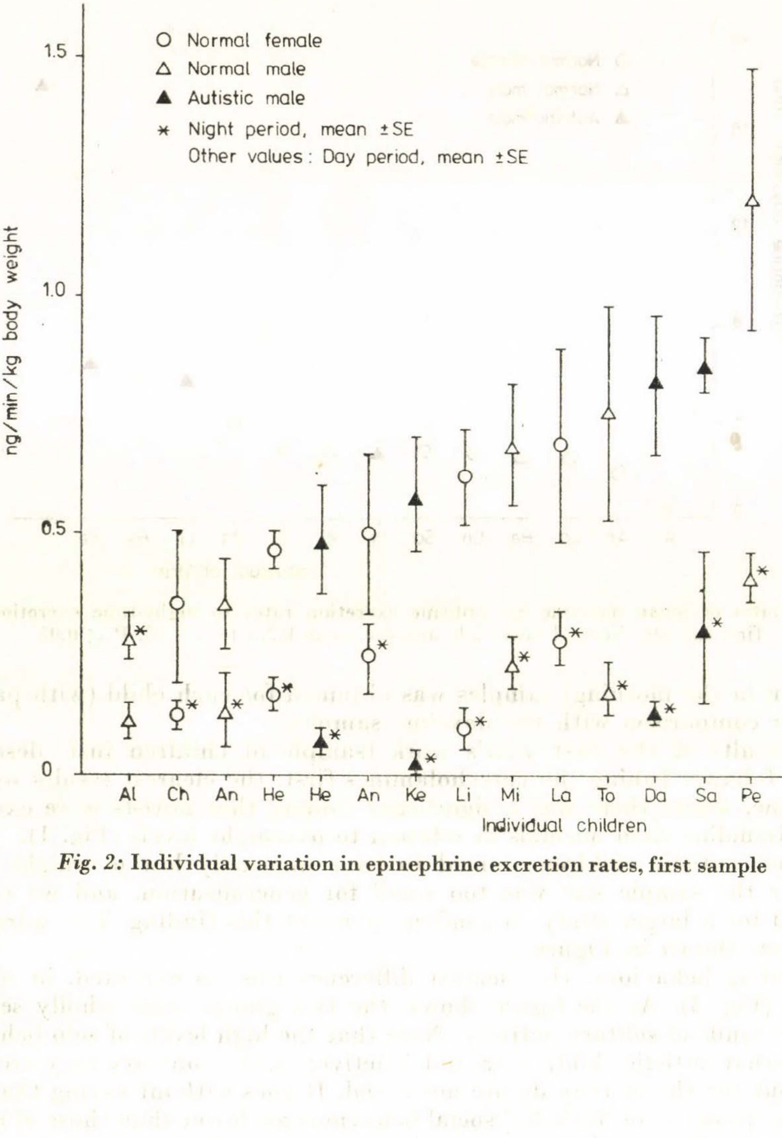


***Fig. 2:* Individual variation in epinephrine excretion rates, first sample**

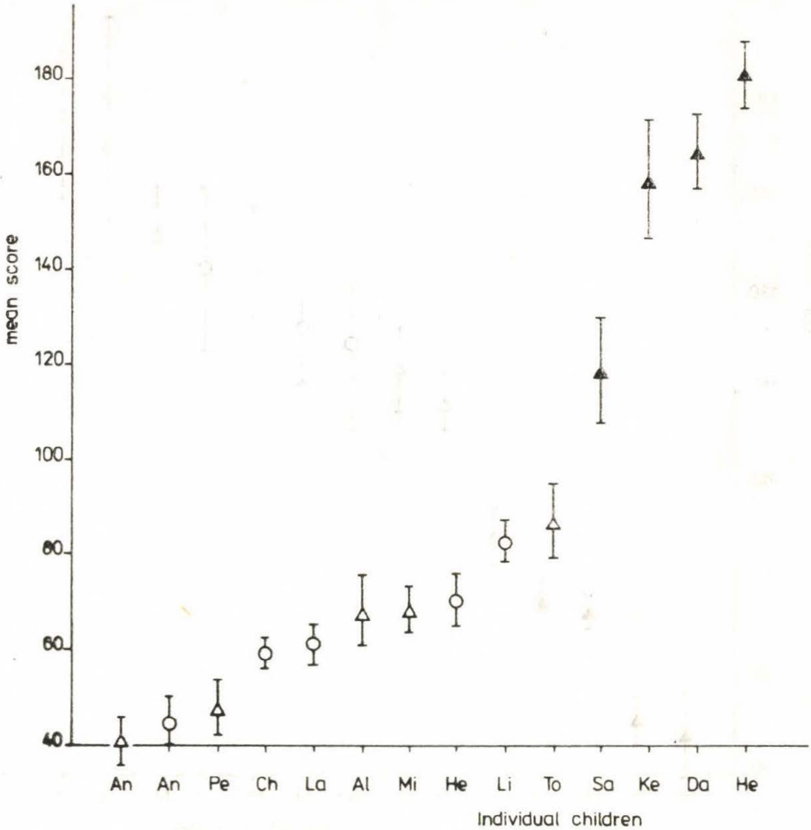


Fig. 3: **Individual variation in solo behaviour, first sample. (For explanation of signs see Fig. 2)**

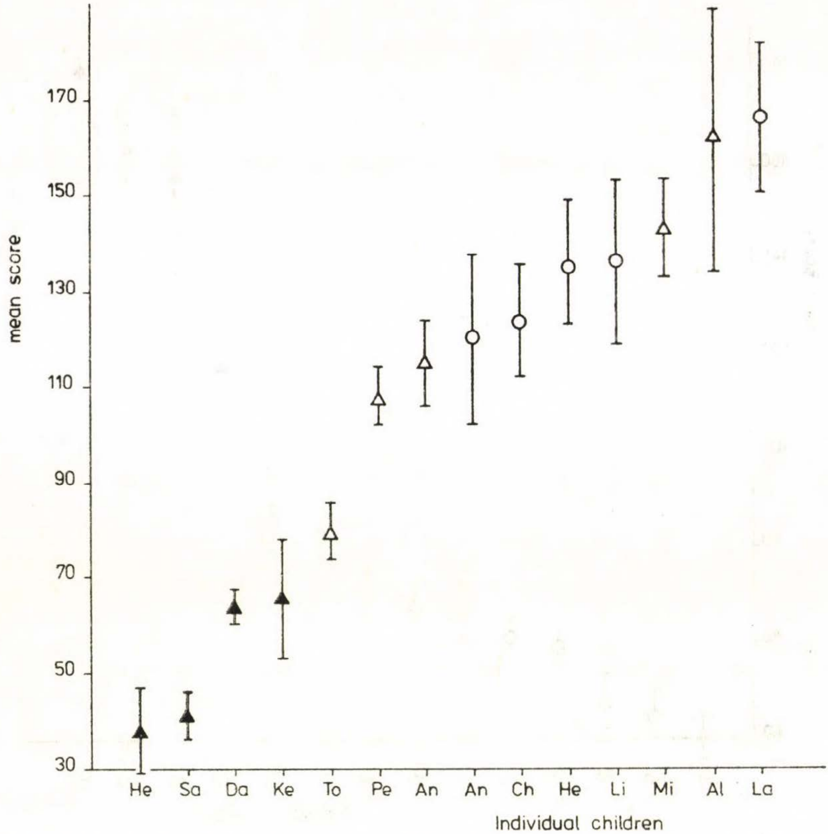


Fig. 4: **Initiate associative behaviour scores, first sample (signs as in Fig. 2)**

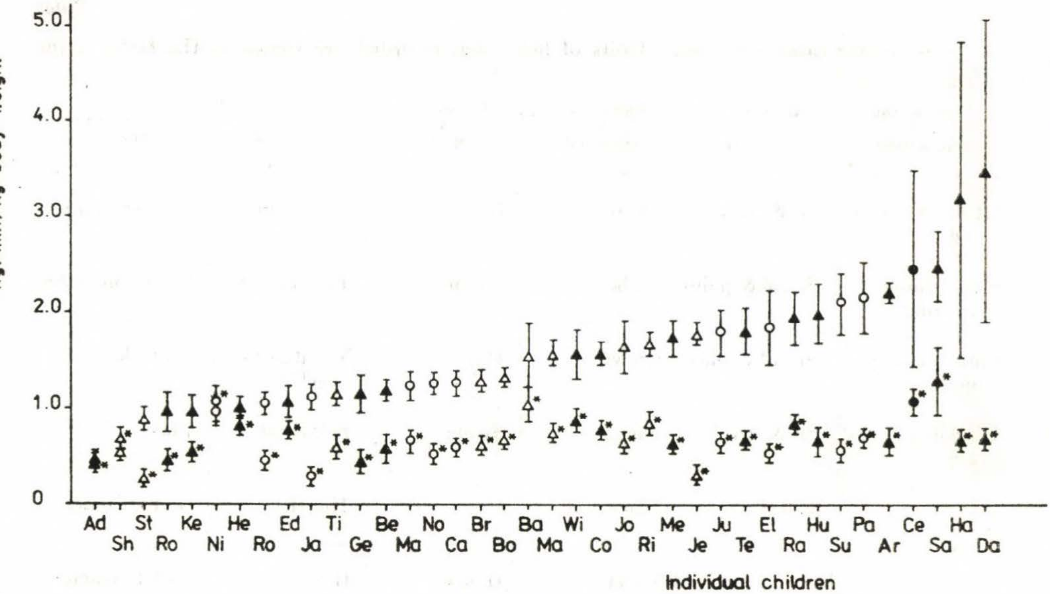


Fig. 5: **Individual variation in norepinephrine excretion rates, second sample (signs as in Fig. 2)**

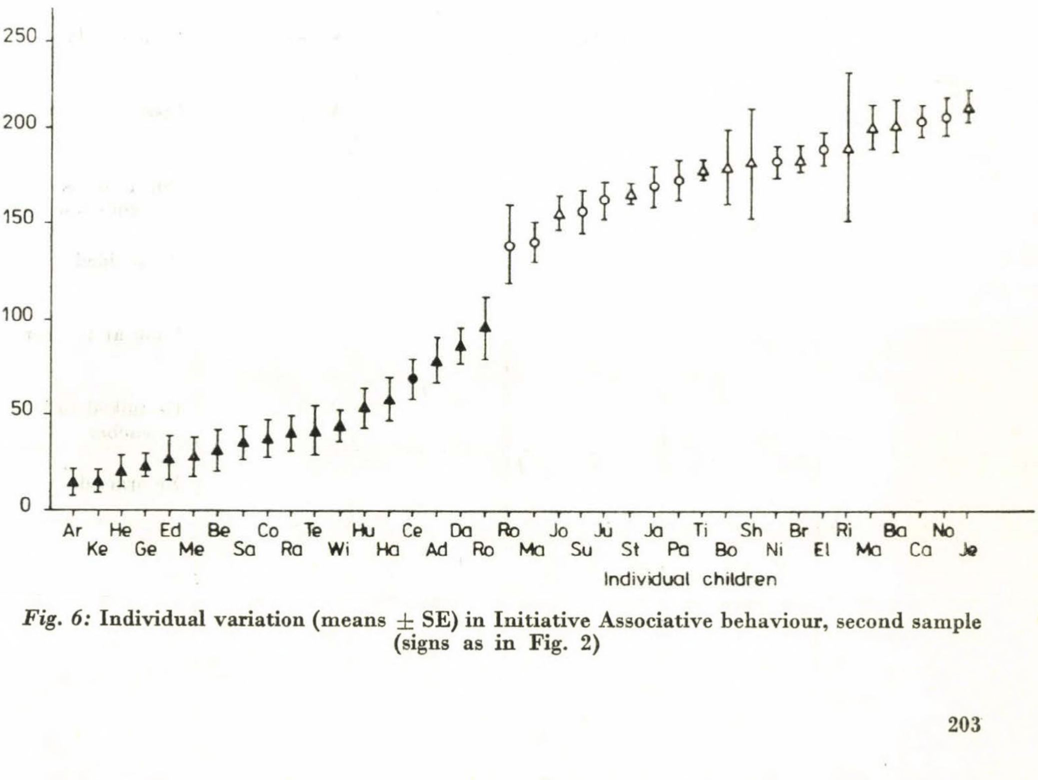


Fig. 6: **Individual variation (means ± SE) in Initiative Associative behaviour, second sample (signs as in Fig. 2)**

Table

Behaviour catalogue used. —Units of behaviour recorded are shown in the body of the

Locomotion 0 (immobile)	Locomotion 1 (Minor)	Locomotion 2 (Medium)	Locomotion 3 (Major)	Solo behaviour	School-oriented behaviour
Sit doing nothing	Sit & write	Climb	Run	Self groom	Be given task
Stand doing nothing	Stand & paint	Walk	Jump	Talk to self	Be commanded
Crouch doing nothing	Stand & play	Crawl	Hop	Vocalize to self	Do task
Lie doing nothing	Sit & drink	Shrug	Swing	Self display	Play
	Kneel	Place walk	Hang	Mouthe	Go to teacher
		Twist	Dance	Gaze	Talk to teacher
		Balance	Play beat	Look at object	Shew to teacher
		Roll	Move heavy things	Glance	Comply
		Any Tremor		Stare	Non-comply
				Watch	Listen
					Question/ask permission
					Be scolded
					Look at teacher
					Be talked to by teacher
					Be praised

table. Column heads denote names of categories into which units were grouped

Initiate associative behaviour	Receive associative behaviour	Initiative assertive behaviour	Receive assertive behaviour	Initiate aggressive behaviour	Receive aggressive behaviour
Smile	Be approached	Command	Be commanded	Provoke	Be provoked
Go to	Receive object	Try to take	Be taken from	Hit	Be hit
Give object	Be helped	Akimbo	Be pointed at	Push	Be pushed
Help	Be soothed	Search	Be asserted to	Grab	Be grabbed
Soothe	Be hugged	Point		Wrestle	Be kicked
Hug	Be patted	Demand		Kick	Be bitten
Pat	Be kissed	Take		Bite	Be schratched
Kiss	Receive contact	Assert		Scratch	Be shown tongue
Physical contact	Receive attention			Tongue out	Be banged
Hand in hand	Be shown to			Bang object with object	Be thrown
Seek attention	Be asked company			Tantrum	
Show to X	Be talked to by peer			Rough and tumble	
Ask company	Be looked at			Throw	
Talk to peer	Be talked to by me				
Talk to me					
Look at peer					
Look at me					

Table 3

Correlations between behaviour scores and catecholamine excretion rate; first sample

Behaviour	Catecholamine	r_s	$P<$
High initiate associative	low E d/n*	0.568	0.05
High initiate aggressive	high MN d	0.542	0.02
High solo	high E d/n	0.749	0.01
High receive associative	low E d/n	0.547	0.05
High initiate assertive	low E d/n	0.640	0.05
High total locomotion	high NE d/n	0.644	0.05
High total locomotion	high MN d/n	0.532	0.05
High total locomotion	high VMA d/n	0.552	0.05

* d, day; d/n, day/night.
r_s: correlation coefficient between behaviour score and catecholamine excretion level (Spearman Rank Correlation, $N = 14$; 10 normals, 4 autists)

confirms earlier Swedish findings, and the work of MONTAGNER et al. (1978) in corticosteroid levels.

Owing to the small sample size, as stated, we repeated the study during the second year on a larger number of children. There were 20 normal and 18 autistic children. The normal children were in a different Oxford primary school. The autists were made up of the 4 from the first sample plus 6 more from that Hospital school plus a further 8 from an autistic school in Ealing. Data were collected on 4 consecutive mornings, together with overnight samples, for all children (Table 4).

Results of the larger second study were in some respects interesting and in others disappointing.

Figure 5 shows the catecholamine results for the second sample, showing noradrenaline on this occasion, mainly to illustrate once again that the extent of intra-individual variation is considerably less than that of inter-individual variation, i.e. children are fairly consistent in their individual catecholamine output levels from day to day, but vary considerably from one another. Autistic children and normals did not differ consistently for any of the catecholamines measured, either with regard to daytime levels or day: night ratios.

In behaviour the same differences were found as before; again there was a complete separation between the autists and the normals with regard to solo behaviour, and associative behaviour (Fig. 6).

Disappointment came, however, when we sought the behaviour: catecholamine correlations found in the first sample. None of the predicted correlations were found. Worse still, no others were found either. In other words, widening the sample size led to the disappearance of *all* the behaviour: catecholamine correlations, and this naturally left us in some bewilderment.

Conclusions

Clearly, the first conclusion we must come to is that there are no one-to-one correlations between types of human behaviour (at least those we studied) and catecholamine excretion levels (perhaps also other aspects of physiology correlated with 'stress').

Table 4

Subjects studied in the second sample

Child	Normal/autistic*	Sex	Age⁑	Wt (kg)
Nora	N	F	81	26
Margaret	N	F	65	20
Patricia	N	F	65	19
Julie	N	F	62	17
Nina	N	F	81	21
Suzanna	N	F	61	19
Rosemary	N	F	63	24
Elizabeth	N	F	62	17
Jayne	N	F	83	23
Carol	N	F	65	22
Richard	N	M	82	24
Bob	N	M	63	20
Shaun	N	M	66	22
Barry	N	M	65	21
John	N	M	63	22
Brian	N	M	83	23
Tim	N	M	62	18
Steve	N	M	82	22
Martin	N	M	81	28
Jeremy	N	M	81	24
Cecily	A	F	125	28
Adam	A	M	120	35
Sam*	A	M	111	27
Ken*	A	M	106	22
Robin	A	M	69	15
Darrell*	A	M	135	35
Henry*	A	M	129	33
Arthur	A	M	136	25
Colin	A	M	125	25
Hubert	A	M	130	29
Terry	AS	M	101	23
Mel	AS	M	137	28
Randolph	AS	M	69	25
William	AS	M	62	23
George	AS	M	155	47
Hamilton	AS	M	118	32
Edward	AS	M	85	26
Ben	AS	M	113	42

* N = normal, A = autistic Smith, AS = autistic Springhallow, ⁑ = age in months, * = also studied in sample I

Second, we can say that while autistic and normal children differ dramatically from each other in their behaviour patterns, physiologically they do not differ, at least not when large samples are considered together.

Nevertheless there are other ways of looking at the data, and this we have done, leading to a more productive conclusion.

The smaller sample had yielded at least *some* correlations and we, therefore, took an entirely different look at the data, considering each individual separately. As already pointed out, children (both normal and autistic) tend to show characteristic forms of behaviour and characteristic catecholamine levels. Since there is no *overall* correlation, we must conclude that individual children have their own characteristic correlation pattern. That, however, tells us nothing in functional terms.

How, then, may catecholamines be related functionally to behaviour? We noted that the autists, behaviourally quite abnormal, were physiologically normal with regard to 'stress' hormone e.g. their stress level was under control at the physiological level. It could, therefore, be that their behaviour has undergone a radical adjustment in order to bring their stress system into a 'normal' region. This would be to regard behaviour as a 'coping' mechanism. If we assume that, for them, social interaction is physiologically stressful, then their withdrawal into themselves is a kind of 'buffering' process, keeping them out of social situations that might be overarousing physiologically and lead to rapid exhaustion.

Although our studies have not yet been adequately designed to test this idea properly, a look at individual cases in the study already made tends to confirm this idea. On a few occasions we were observing autistic children who for some reason were forced into social interaction. In one case, for example, a boy dropped a bottle of milk and was told off for it during our study period. The result in terms of his adrenaline level was dramatic — it rose exceptionally high.

This too, of course, ties in with our other studies on individuals mentioned at the outset, and the work of others relating adrenaline to *perceived* stress. But more importantly it does two things. First it supports the idea (which has been and still is challenged) that autistic children are showing a response to stress. We suggest they have been badly stressed and have responded by withdrawal. We do not conclude that the stress could have been avoided or that anyone is to blame for it — these children may even be genetically oversensitive to normal situations.

Second, we can see the general relation between behaviour and physiological levels as one in which the former serves as a kind of adaptation to the perceived environment, making sure the body systems have the best chance of normal, regular functioning (only occasionally subjecting it to insults, e.g. when drinking heavily or engaging in athletic sports). Most particularly, we use our social behaviour to regulate the nervous stress resulting from social relationships. This is a subject that needs much further study.

REFERENCES

CANNON, W. B. (1953): *Bodily Changes in Pain, Hunger, Fear and Rage.* (2nd edn.) — Branford, Boston.

HELEVUO, H. (1978): *A study of catecholamine excretion and behaviour patterns in normal and autistic children.* (D. Phil. thesis.) — Oxford University, Oxford.

LEVI, L. (Ed.) (1971): *Society, Stress and Disease.* — Oxford University Press, Oxford.

MASON, J. W. (1968): A review of psycho-endocrine research. — Psychosom Med. *30;* 5.

RICHER, J. (1976): The social avoidance behaviour of autistic children. — Animal Behaviour, *24;* 896—906.

TINBERGEN, E. A.—TINBERGEN, N. (1972): Early childhood autism, an ethological approach. — Advances in Ethology. Supplement 10; Journal of Comparative Ethology.

Author's address: Prof. Dr. V. REYNOLDS
Dept. Biological Anthropology, Oxford University
58 Banbury Road
Oxford OX2 6QS
England

Anthrop. Közl. *24;* 209–212. 1980.

ON THE RELATIONSHIP BETWEEN THE NUMBER OF SIBS, RANK IN SIBSHIP AND THE WEIGHT DEVELOPMENT IN CHILDREN AND JUVENILES

by J. Richter

(Public Health Office for Children and Juveniles, Görlitz, G. D. R.)

Abstract. For a regular consecutive routine examination of 2398 Goerlitz children, born in the years from 1957 to 1959 and studied over a 15 years period, correlations between weight development and the number of siblings, as well as the position in the sibship were observed. Contrary to many statements appearing time and again on the anthropological and medical literature during the past decades, the author states on the basis of his examination results, that neither the number of siblings nor the position in the sibship has any significant influence on the development of the body weight of children and juveniles.

Key words: growth and development, weight, number of sibs, rank in sibship, Görlitz/GDR.

Of a variety of anthropological phenomena we know today for sure that in children of the same parents they show a direct dependence on the number of sibs or on the rank of the proband in the sibship, respectively. We thus reppeatedly found, for instance, correlative coherence between age at menarche and number of sibs (Richter 1970). We are also able to ascertain that only children experience their menarche significantly earlier than children having one or two sibs, and in these girls — again statistically ascertained — it appears distinctly earlier than in children with three or more sibs (Richter 1971).

With regard to the weight development of children, Knussmann (1976) as well as Pudel and Jung (1974, 1975) claim that overweight was to be most frequently observed with only children. Gossmann and Sender–Erpelt (1976) state that overweight children more often stem from small families and, in particular, are more often only children than their slender contemporaries. From 83 adipose juveniles 14 (16.9%) were only children, while in another control group of 84 non-adipose juveniles there were only 9 (10.7%). In families with one adipose child the average number of children per familiy was 2.6 as compared with 3.14 children in families of the control group. Spranger (1975) points out that obese children are more frequently only children. In his investigation on 300 adipose pupils, Dehler (1975) found more than 50% only or first children. Only 25% came from large families. The authors attaching importance to the only child situation the development of overweight, prove this with slight variations like Bruch (1970), who points out that parents often tend to consider their only child a particularly precious property upon whom the best of treatments is bestowed including — wrongly though — overfeeding, but disregard the actual needs of the child. It is considered rather an object whose task is to meet the pretensions of its parents and to make up for any failures and frustrations they may have suffered in their own lives. SÄLZLER (1964) postulates a relation between number of children and body development as being highly independent of the social surroundings, i.e. for instance, an insignificantly lower average weight can be found with four or more children in the family. With 6.6 years old boys the author could observe an average weight of 21.05 kg. Only children and children with one sib weighed 21.31 kg on an average, whereas the mean value for children with three or more sibs was 19.22 kg. With adipose 10 years old boys TIEFENBACH (1966) finds an average of 1.7 sibs, with normal weight boys 1.8, consequently no statistical significance. In his opinion the only child situation was by no means more frequent for the adipose than for the normal weight child.

The position of the adipose child in the family is striktingly often exposed to disadvantages. In the majority of cases they are pampered late-born or first children who have been handicapped by a rapid succession of further sibs. According to GUTEZEIT (1972) only and late-born children are often exposed to overprotective mothers.

Among 300 adipose children DEHLER (1975) found 51% first ones. Also BOLTE (1975) could observe only child situation with overweight children at a greater than accidental frequency or, contrary to this, a position as the youngest child in the sibship. TIEFENBACH (1966), however, could neither confirm the significance of the birth succession for the future development of body weight, nor did he observe any conspicuities in the position of the overweight children within the sibship. Since there are still rather contradictory opinions as to the problems of the relation between body weight development, on the one hand, and the position in the sibship as well as the number of sibs, on the other, we incorporated this set of problems in the evaluation of a series of longitudinal examinations in Goerlitz children.

In present a brief report on the results of our investigations is as follows.

From the day of their birth up to their graduation from school, all children born in Goerlitz between 1957 and 1959 were subject to regular longitudinal series examination on which we previously reported several times (GRZEGOREK et al. 1977, KIRBIS et al. 1978, 1979, RICHTER 1970, 1971, 1977, 1978a, 1978b, 1979a, 1979b). During their first year of life all children were examined at least once a month, in their second and third years at least once in three months, then till school-age at least once a year and, during the entire time of their school education, at three years interval. The last examination took place within the medical examination at leaving school which, as a matter of principle, is being carried through in the ninth class so that the time necessary for vocational guidance and rehabilitative measures can be gained. Thus the findings of altogether 2.398 examined children (1.215 boys and 1.183 girls) were available for evaluation. We took the somatograms of MARCUSSON (1961) as a basis for the valuation of the body weight. The statistical evaluation of the findings was performed at the computation center of the Martin Luther University, Halle-Wittenberg.

As to the number of sibs and the body weight pattern, we could not find any statistically significant correlations. Our results are thus in absolute conformity with the findings of TIEFENBACH (1966). The global statements of the other authors on existing correlations cannot be confirmed by us in any detail. Of interest is the fact, that among our probands we found 17.4% only children, 35.5% children with one sib, 23.2% with two sibs and 12% each three, four and more sibs, respectively.

Regarding the relationship between body weight pattern and position in the sibship our extensive findings did not allow us to confirm the accordant statements of the authors postulating such a relationship either. At no time of the investigation did the statistical analysis prove any significant relationship between deviation from the standard weight and the position in the sibship, not even when the sex of the probands was taken into consideration. Thus also in this report our statements confirm the findings of TIEFENBACH (1966) who did not find any correlation between the rank in the sibship and later body weight development.

REFERENCES

BOLTE, R. (1975): cit. PUDEL—JUNG, 1974.

BRUCH, H. (1970): cit. GOSSMANN—SENDLER-ERPELT, 1976.

DEHLER, O. (1975): Erfahrungen mit einer neuen Form der Adipösenbetreuung im Jugendgesundheitschutz. — Ärztl. Jugendkde. *68;* 320—331 (1975).

GOSSMANN, H.—SENDLER-ERPELT, S. (1976): Konstitution und Fettsucht bei Jugendlichen. — Med. Klin. *71;* 2007—2012.

GRZEGOREK, R.—KIRBIS, U. (1977): Zur Gewichts- und Längenentwicklung von Kindern und Jugendlichen unter besonderer Berücksichtigung einiger anthropometrischer, anamnestischer und soziologischer Parameter. Med. Diss. A, Halle (Saale).

GRZEGOREK, R.—KIRBIS, U.—RICHTER, J. (1977): Zur Morbidität bedeutsamer Infektionskrankheiten. — Ärztl. Jugendkde. *68;* 233—237.

GUTEZEIT, G. (1972): Eltern-Kind-Relationen bei adiopösen Kindern. — *In:* GRÜTTNER, R. and ECKERT, I. *Adipositas im Kindesalter.* — Georg Thieme Verlag, Stuttgart.

KIRBIS, U.—GRZEGOREK, R.—RICHTER, R. (1978): Gewichtsentwicklung Görlitzer Kinder. — Ärztl. Jugendkde. *69;* 90—96.

— — — (1979): Zum Zusammenhang zwischen Übergewicht und Hypertension im Kindes- und Jugendalter. — Dtsch. Ges. wesen *34;* 1433—1436 (1979).

KNUSSMANN, R. (1976): Warum viele Menschen so dick werden? — Zschr. Allgemein med. *52;* 1753—1757.

MARCUSSON, H. (1961): Das Wachstum von Kindern und Jugendlichen in der DDR. Akademie-Verlag, Berlin.

PUDEL, V.—JUNG, F. (1974): Appetitverhalten unter experimentellen Bedingungen bei Normal- und Übergewicht. — *In:* GRÜTTNER, R. und ECKERT, I. (Eds): *Adipositas im Kindesalter.* — Georg Thieme Verlag, Stuttgart.

— — (1975): Psychologische und psychosoziale Faktoren bei der Genese der kindlichen Adipositas. — Mschr. Kinderheilkde. *123;* 255—258.

RICHTER, J. (1970): Weitere Ergebnisse von Menarcheuntersuchungen in Görlitz. — Ärztl. Jugendkde. *61;* 371—378.

— (1971): Das Akzelerationsgeschehen und seine Beziehungen zu soziologischen, anthropologischen und bioklimatischen Gegebenheiten, dargestellt an der Menarchesituation Görlitzer Mädchen. — Med. Diss. B., Halle (Saale).

— (1978/a): Das Körperhöhenwachstum Görlitzer Kinder. — Ärztl. Jugendkde. *69;* 157—164.

— (1977): Tonsillektomie- und Appendektomiehäufigkeit in einer Kinderpopulation. — Ärztl. Jugendkde. *68;* 238—241.

— (1978/b): Zum Einfluß des Geburtsgewichts auf die weitere Gewichtsentwicklung von Kindern und Jugendlichen. — Ärztl. Jugendkde. *69;* 225—230.

— (1979): Der Einfluß der Körperlänge bei Geburt auf die weitere Körperlängenentwicklung. Ärztl. Jugendkde. *70;* 1—5.

— (1980): Übergewichtigkeit im Kindes- und Jugendalter. — Ärztl. Jugendkde *71;* 196—204.

SÄLZLER, A. (1964): Zur Problematik der kindlichen Entwicklung. — Zschr. ärztl. Fortbild. *58;* 1090—1101.

SPRANGER, J. (1975): Symptomatologie und Systematik der Adipositas. — Mschr. Kinderheilkde. *123;* 242—246.

Tiefenbach, W. (1960): Zur Entwicklung und Erziehungssituation des adipösen Kindes. — Ärztl. Jugendkde. *57;* 81–82.
— (1980): Vergleichende Untersuchung über den Körperbau adipöser Kinder in der Vorpubertät. — Ärztl. Jugendkde. *57;* 340–356.

Author's address: Dr. Joachim Richter
Carl-von-Ossietzky-Str. 38.
DDR-8900 Görlitz
G.D.R.

Anthrop. Közl. *24;* 213–222. 1980.

POSTURAL CHANGES DUE TO KYPHOSIS AND LORDOSIS IN FEMALES WITH SPECIAL REGARDS TO SENESCENCE

by L. S. SIDHU and P. SINGAL

(Department of Human Biology, Punjabi University, Patiala, India)

Abstract. The postural changes in the females of two important communities of Panjab: Jat Sikh and Bania have been studied in the present paper. These two communities are traditionally engaged in different types of occupation. The former is an agriculturist, the latter a trading community. Kyphosis and lordosis have been measured with a flexicurve on 502 Jat Sikh and 510 Bania women. The range of ages of the sample varies from 20 to 80 years. An attempt has been made to study the postural changes due to kyphosis in relation to occupation, climacterics, spinal length and body weight. Kyphosis was found to increase with age, especially after the age of 50. Climacterics and body weight seem to play an important role in modifying the shape of the spinal curvature.

Key words: physique, postural changes, aging, kyphosis, lordosis, Jat-Sikh women, Banias women, India.

Introduction

A special feature of old age is the change in posture. An increase of kyphosis and a decrease of lordosis with increasing age have been reported by many investigators (TAKAHASHI and ATSUMI 1955, COWAN 1965, ABE 1971, URIST et al. 1970, MILNE and LAUDAR 1974). These changes in the spinal curvature have been attributed to different factors by different investigators. TAKAHASHI and ATSUMI (1955) attributed them to life-long habits of posture and occupation. ABE (1971) studied two communities engaged in farming and fishing and attributed the changes to the differences in the intake of food as more kyphosis was found in the farming community. URIST et al. (1970) indicated that in aging women osteoporosis led to accentuation of the dorsal posterior curve and reversal of the anterior lumbar curve with increasing age. MILNE and LAUDAR (1974) reported the increase in kyphosis and decrease in lordosis due to aging after 50 years of age in females and 60 years of age in males. Bowed legs with flat feet due to aging have also been reported by HIMES and MUELLER (1977). The present paper is a part of the study of morphological age changes in the females of two communities. In this paper only the changes in the spinal curvature with increasing age have been dealt with.

Material and Methods

The results are based on cross sectional data collected in 1012 subjects (502 Jat-Sikhs 510 Banias) ranging in age from 20 to 80 years. These two communities are endogamous on caste level. The Jat-Sikh is traditionally an agriculturist community which lives mostly in villages, whereas the Bania is traditionally a trading community and is mostly living in cities.

The spinal curvature and the overlying fatty tissue have been recorded with the help of a "flexicurve". This instrument is a strip of lead wires covered with plastic and is about 60 cm in length. It bends in one plane only and retains the shape into which it is bent, so it can be used to copy any curved surface. It is placed on the subject's back, with one end on the 7th cervical spine and closely applied to the midline of the back, the subject being asked to stand as erect as possible. The level of the lumbosacral joint is marked on the flexicurve with a grease pencil, after which the instrument is laid on a white sheet of paper and the spinal curve copied by running a pencil along the flexicurve. The letters used in describing the curve are presented in Fig. 1 (after MILNE & LAUDAR 1974).

In Fig. 1 H represents the whole length of the curve and is called spinal length. The end of the curve has been joined with a straight line. Perpendiculars B and D drawn to the points farthest from the straight line show the measure of kyphosis and lordosis, respectively. Dimension E is that part of the straight line, from the cephalic end of the curve to the point, where the curve crosses the straight line. Dimension G is the kyphotic part of the curve which corresponds to E.

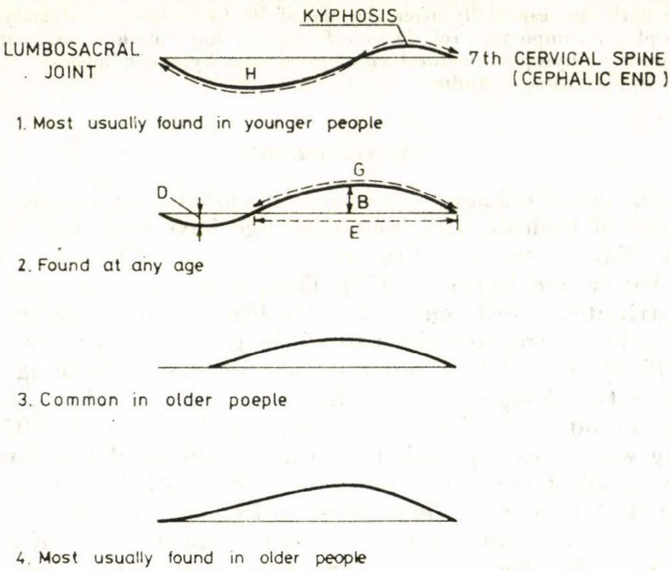


Fig. 1: **Types of spinal curve recorded with the flexicurve (after MILNE and LAUDAR 1974)**

Results and Discussion

Kyphosis

The changes with increasing age in perpendicular B (kyphosis) are presented in Table 1 and Fig. 2. It has been observed that there is a general trend of increase in kyphosis up to the age group of 35—39 years. The condition has

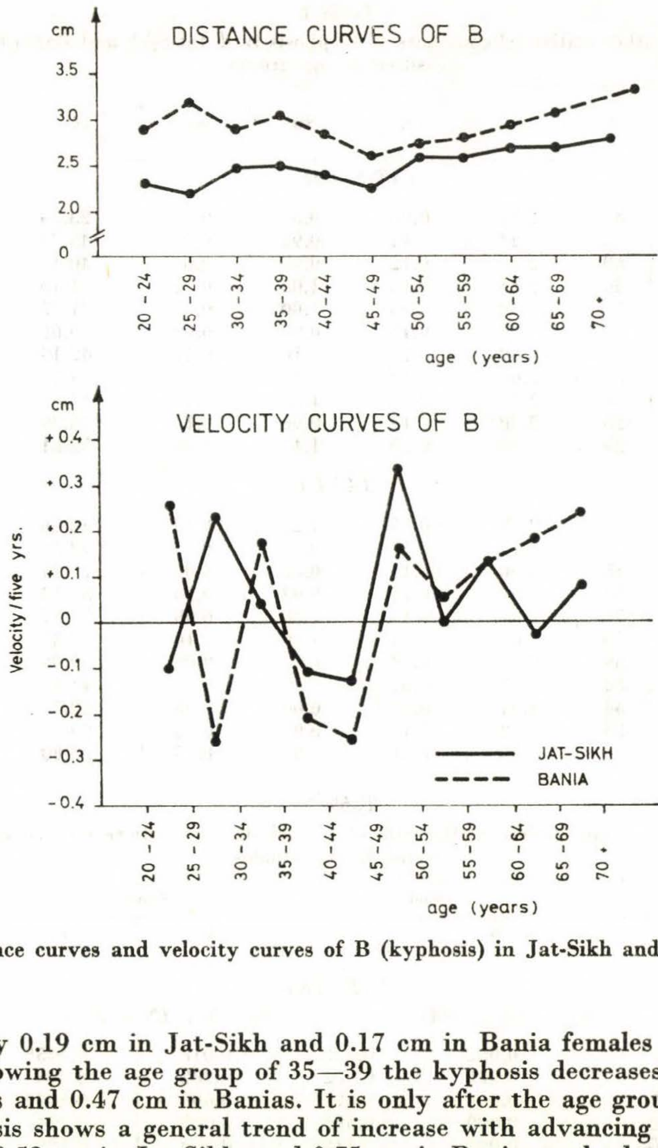


Fig. 2: **Distance curves and velocity curves of B (kyphosis) in Jat-Sikh and Bania women**

increased by 0.19 cm in Jat-Sikh and 0.17 cm in Bania females of that age group. Following the age group of 35—39 the kyphosis decreases by 0.24 cm in Jat-Sikhs and 0.47 cm in Banias. It is only after the age group of 45—49 that kyphosis shows a general trend of increase with advancing age. A total increase of 0.52 cm in Jat-Sikhs and 0.75 cm in Banias took place up to 70+ years of age.

As evident from the distance and velocity curves the pattern of increase and decrease is similar in the two communities.

While calculating correlations of B with age, spinal length and weight, it is been noticed that B is also dependent upon these measurements (Tables 2, 3 and 4). So that only the effect of age on kyphosis could be studied, a variable was selected, which measured the effect of age on kyphosis and was least affected by spinal length and weight. For this purpose variables log B, B/E, B/G, and B/H were examined.

Table 1

Mean and some other statistical constants of Kyphosis B of Jat-Sikh and Bania females, classified in age groups

Age group (yr)	N	Mean	SE	SD	SE	CV	Velocity
			JAT-SIKH				
20–24	49	2.32	0.08	0.55	0.06	23.59	—
25–29	68	2.24	0.12	0.98	0.08	43.73	–0.08
30–34	69	2.47	0.12	0.99	0.08	40.17	0.23
35–39	50	2.51	0.15	1.03	0.10	41.13	0.04
40–44	57	2.40	0.13	1.00	0.09	41.55	–0.11
45–49	52	2.27	0.13	0.90	0.09	39.68	–0.13
50–54	45	2.60	0.16	1.10	0.12	42.19	0.33
55–59	35	2.60	0.19	1.13	0.13	43.31	0.00
60–64	26	2.73	0.25	1.30	0.18	47.62	0.13
65–69	25	2.70	0.19	0.96	0.14	35.39	–0.03
70+	26	2.78	0.29	1.47	0.20	52.81	0.08
			BANIA				
20–24	53	2.90	0.17	1.27	0.12	43.86	—
25–29	45	3.16	0.11	0.75	0.08	23.86	0.26
30–34	55	2.90	0.11	0.82	0.08	28.21	–0.26
35–39	44	3.07	0.15	0.97	0.10	31.73	0.17
40–44	70	2.86	0.13	1.08	0.09	37.57	–0.21
45–49	59	2.60	0.14	1.10	0.10	42.35	–0.26
50–54	59	2.76	0.13	0.99	0.09	35.96	0.16
55–59	32	2.81	0.07	0.40	0.05	41.23	0.05
60–64	34	2.94	0.11	0.66	0.08	22.38	0.13
65–69	25	3.12	0.18	0.91	0.13	29.33	0.18
70+	34	3.35	0.21	1.20	0.15	35.80	0.23

Table 2

Regression and correlation coefficients of B and derived indices on age in Jat-Sikh and Bania females

Index	Females		Females	
	K	r	K	r
		JAT-SIKH		
	20–49 (N = 344)		45–70+ (N = 209)	
B	0.002	0.022	0.018	0.145*
log B	–0.000	–0.002	0.002	0.096
B/H	0.000	0.027	0.000	0.169*
B/E	0.000	0.093	0.000	0.134
B/G	0.000	0.112*	0.000	0.128
		BANIA		
	20–49 (N = 326)		45–70+ (N = 243)	
B	–0.012	–0.099	0.027	0.277*
log B	–0.002	–0.081	0.005	0.291*
B/H	–0.000	–0.008	0.001	0.323*
B/E	–0.000	–0.060	0.001	0.334*
B/G	–0.000	–0.056	0.001	0.339*

* Statistically significant at 5% level

Table 3

Regression and correlation coefficients of B and derived indices on spinal length (H)

Index	Females		Females	
	K	r	K	r
	JAT-SKIH			
	20–49 (N = 344)		45–70+ (N = 209)	
B	0.111	0.276*	0.118	0.269*
log B	0.024	0.267*	0.021	0.252*
B/H	0.001	0.143*	0.001	0.134
B/E	0.002	0.221*	0.002	0.228*
B/G	0.002	0.210*	0.002	0.224*
	BANIA			
	20–49 (N = 326)		45–70+ (N = 243)	
B	0.145	0.335*	0.076	0.199*
log B	0.023	0.296*	0.011	0.174*
B/H	0.002	0.180*	0.000	0.007
B/E	0.003	0.275*	0.000	0.031
B/G	0.003	0.272*	0.000	0.023

* Statistically significant at 5% level

Table 4

Regression and correlation coefficients of B and derived indices on weight in Jat-Sikh and Bania females

Index	Females		Females	
	K	r	K	r
	JAT-SIKH			
	20–49 (N = 344)		45–70+ (N = 209)	
B	0.011	0.123*	−0.006	−0.053
log B	0.002	0.121*	−0.000	−0.004
B/H	0.000	0.076	−0.000	−0.096
B/E	0.000	0.152*	0.000	0.006
B/G	0.000	0.155*	0.000	0.004
	BANIA			
	20–49 (N = 326)		45–70+ (N = 243)	
B	0.021	0.230*	0.004	0.054
log B	0.003	0.207*	0.001	0.065
B/H	0.000	0.221*	−0.000	−0.015
B/E	0.001	0.234*	−0.000	−0.064
B/G	0.000	0.237*	−0.000	−0.067

* Statistically significant at 5% level

The effect of age, spinal length and weight on B and its derived variables were estimated from linear regressions, with B and its derived variables as dependent variables; age, spinal length and weight as independent variables.

Due to different patterns of increase or decrease, the regressions were applied by splitting up the data into two major groups, i.e. from 20—24 to 45—49 and from 45—49 to over 70 in both communities. Age group 45—49 covers a transitional period during which the effect of age on B begins to appear.

The age effect is shown in Table 2, where B and the indices derived from it, are dependent variables, which have been regressed with age. No significant age effect has been found in younger age group of 20—49, whereas in the older age groups of 45 to 70 over, the value of the correlation coefficient is significant. Also the variables derived from B behave in a similar fashion, since they are

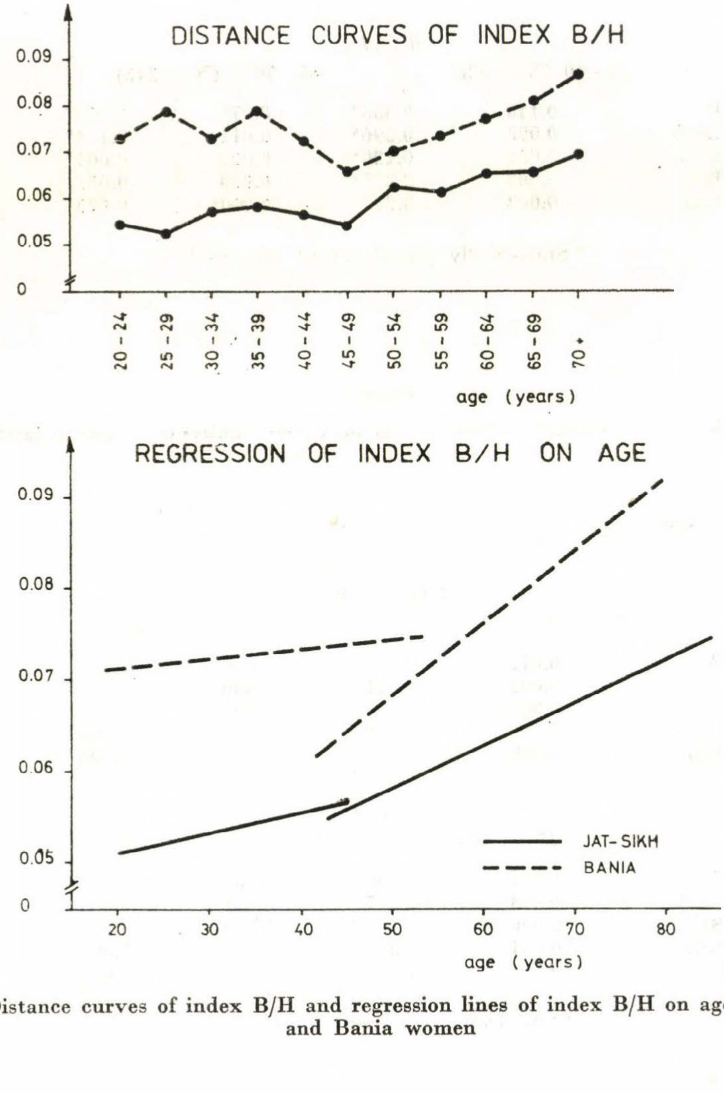


Fig. 3: Distance curves of index B/H and regression lines of index B/H on age in Jat-Sikh and Bania women

simple functions of B, however, in Jat-Sikh females log B, B/E and B/G presented non-significant values with age.

Variable B and its derived indices are each regressed on spinal length in the same age groups as those used in the regression on age. The regression and correlation coefficients are given in Table 3. The clearest evidence of the larger dependence of B and the derived variables on spinal length, is found in younger age groups both in the Jat-Sikh and the Bania females, in whom no age effect that could bias the regression on spinal length was found. The index least dependent on spinal length is B/H.

Similarly, variable B and its derived indices were regressed on weight as presented in Table 4. The regression and correlation coefficients of weight with B and its derived indices indicate a significant effect of weight only up to age group of 45—49 but after that age weight is not responsible for increase in kyphosis.

Therefore, an index B/H minimally dependent on spinal length and weight has been chosen for studying changes with age in kyphosis (Fig. 3). Index B/H shows a slight increase up to age group 35—39, followed by a decrease up to that of 45—49 years of age in both communities (Table 5, Fig. 3). There has been observed a continuous increase from 45—49 years of age up to the last age group of 70 years or older. The increase of kyphosis during the period from age group 20—24 to 35—39 may be attributed to the increase of weight

Table 5

Mean and some other statistical constants of index B/H of Jat-Sikh and Bania females classified in age groups

Age group (yr)	N	Mean	SE	SD	SE	CV	Velocity
			JAT-SIKH				
20—24	49	.054	.002	.013	.001	23.64	—
25—29	68	.052	.003	.022	.002	42.29	—0.002
30—34	69	.057	.003	.023	.002	39.48	0.005
35—39	50	.058	.003	.023	.002	39.88	0.001
40—44	57	.056	.003	.022	.002	39.92	—0.002
45—49	52	.054	.003	.021	.002	38.75	—0.002
50—54	45	.062	.003	.024	.002	38.82	0.008
55—59	35	.061	.004	.026	.003	41.81	—0.001
60—64	26	.065	.006	.030	.004	46.72	0.004
65—69	25	.066	.005	.024	.003	36.09	0.001
70+	26	.067	.006	.033	.005	49.50	0.001
			BANIA				
20—24	53	.071	.004	.028	.003	39.63	—
25—29	45	.078	.003	.019	.002	23.96	0.007
30—34	55	.072	.003	.020	.002	27.49	—0.006
35—39	44	.077	.004	.024	.003	30.81	0.005
40—44	70	.072	.003	.026	.002	36.11	—0.005
45—49	59	.066	.003	.026	.002	39.72	—0.008
50—54	59	.070	.003	.025	.002	35.75	0.004
55—59	32	.073	.002	.011	.001	14.42	0.003
60—64	34	.077	.003	.017	.002	22.33	0.004
65—69	25	.081	.005	.024	.003	29.04	0.004
70+	34	.087	.005	.029	.003	32.81	0.016

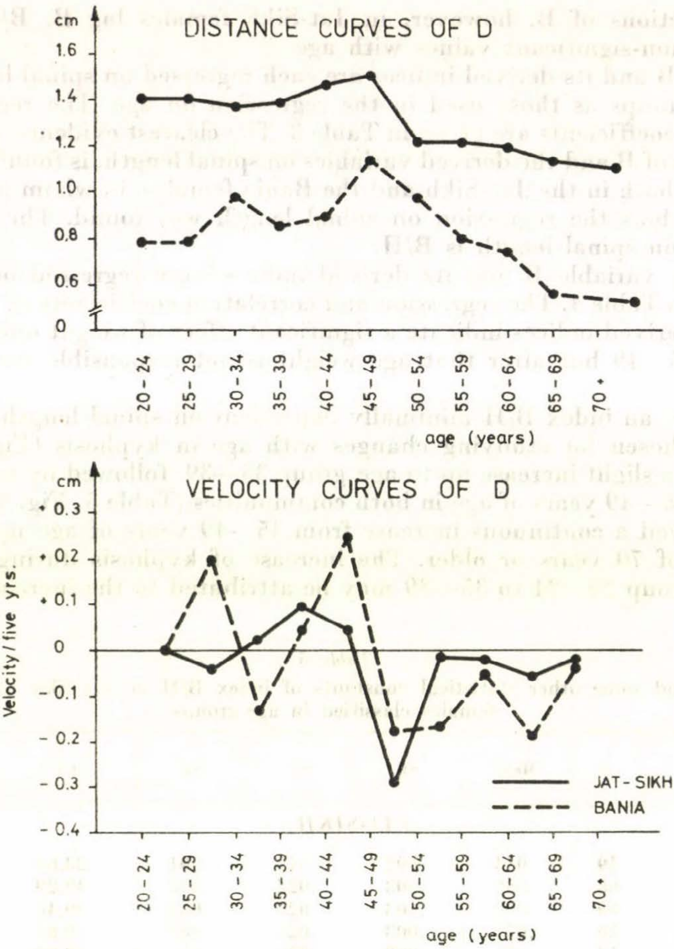


Fig. 4: **Distance curves and velocity curves of D (lordosis) in Jat-Sikh and Bania women**

during this period, because a heavier weight of the body tends to increase the thoracic curve, and pronounced kyphosis occurs. The decrease in kyphosis observed from age group 35—39 to 45—49 may be attributed in both communities to an increase in fat on the abdomen and hips during this period. In order to restore the centre of gravity to an approximately normal position, there is an increase of lordosis (Table 6, Fig. 4) and decrease of kyphosis. Takahashi and Atsumi (1955), Cowan (1965), Abe (1971) and Milne and Laudar (1974) have also reported on an increase of kyphosis and decrease of lordosis with advancing age in both sexes.

At all ages the mean values of kyphosis are higher in the Bania community than in the Jat-Sikh community. As already discussed, the Bania females lead a very comfortable and sedentary life. The sitting hours are certainly more in Bania females than Jat-Sikh ones, which leads to more kyphosis

because as they work while sitting, there is a greater tendency for this condition. Also heavier weight may be responsible for more kyphosis in Bania females.

Table 6

Mean and some other statistical constants of Lordosis D of Jat-Sikh and Bania females classified in age groups

Age-group (yr)	N	Mean	SE	SD	SE	CV	Velocity
			JAT-SIKH				
20–24	49	1.41	0.09	0.65	0.07	—	—
25–29	68	1.41	0.11	0.87	0.53	—	0.00
30–34	69	1.37	0.09	0.76	0.06	—	−0.04
35–39	50	1.39	0.12	0.79	0.08	—	0.02
40–44	57	1.48	0.09	0.69	0.06	—	0.09
45–49	52	1.52	0.10	0.67	0.07	—	0.04
50–54	45	1.23	0.12	0.78	0.08	—	−0.29
55–59	35	1.22	0.12	0.70	0.09	—	−0.01
60–64	26	1.20	0.15	0.74	0.11	—	−0.02
65–69	25	1.14	0.12	0.58	0.09	—	−0.06
70+	26	1.12	0.21	0.99	0.15	—	−0.02
			BANIA				
20–24	53	0.78	0.07	0.47	0.05	—	—
25–29	45	0.78	0.07	0.49	0.05	—	0.00
30–34	55	0.98	0.09	0.64	0.06	—	0.20
35–39	44	0.85	0.09	0.61	0.07	—	−0.13
40–44	70	0.90	0.07	0.61	0.05	—	0.05
45–49	59	1.15	0.07	0.53	0.05	—	0.25
50–54	59	0.97	0.11	0.80	0.07	—	−0.18
55–59	32	0.80	0.11	0.62	0.08	—	−0.17
60–64	34	0.75	0.09	0.51	0.06	—	−0.05
65–69	25	0.56	0.07	0.32	0.05	—	−0.19
70+	34	0.53	0.10	0.55	0.07	—	−0.03

Lordosis

Perpendicular D wich measures lordosis, is almost stable up to age group 35—39 with a subsequent increase up to 45—49 years in both the communities (Table 6, Fig. 4). Incidentally an increase in fat on the hips and abdomen was also noticed during this age period. Therefore, in order to restore the centre of gravity to an approximately normal position the surveyed persons display an increase of lordosis and decrease of kyphosis. There is a continuous decline in the value of lordosis following age group 45—49 and, in some individuals, lordosis has been found to be altogether absent. The decrease in lordosis after 50 and its absence in some individuals of old age may be a result of increasing kyphosis, and of pushing the centre of gravity of the body forwards, concomitant with decreased lordosis resulting from compensatory straightening of the lower spinal curve. MILNE and LAUDAR (1974) also reported a steep fall in lordosis after the age group 55—64 years. ABE (1971) also reported a decrease of lordosis after the age group 40—49.

The mean values for lordosis are larger in Jat-Sikh females in all age groups studied, which may be attributed to a more strenuous and active way of life in this community.

Summary

The postural changes in the trunk region of the females of the two important communities of Punjab: Jat-Sikhs and Banias have been studied in the present paper. The two communities are traditionally engaged in different types of occupation. The former is an agriculturist and the latter a trading community. The results are based on a cross sectional data collected on 502 Jat-Sikh and 510 Bania females ranging from 20 to 80 years in age. A flexicurve has been used to measure kyphosis and lordosis. Kyphosis was observed to be influenced by weight and spinal length. Therefore, various indices were examined to test the suitability of these as estimates of measuring kyphosis due to age only. Linear regression of the B/H index on age showed an increase with age in kyphosis from age group 45—49 to 70 and over. Lordosis has been found to decrease following age group 45—49.

REFERENCES

ABE, S. (1971): Epidemiological studies on the different occurrence of senile vertebral crookedness in form and fishing villages (in Japan). — Race Hyg., *37;* 35.

COWAN, N. R. (1965): The frontal cardiac silhouette in older people. — Brit. Heart J., *27;* 231.

HIMES, J. H.—MUELLER, W. H. (1977): Ageing and secular change in adult stature in rural Colombia. — Am. J. Phys. Anthrop., *46;* 275.

MILNE, J. S.—LAUDAR, I. J. (1974): Age effects in kyphosis and lordosis in adults. — Ann. Hum. Biol., *1;* 327.

TAKAHASHI, E.—ATSUMI, H. (1955): Age differences in thoracic form as indicated by thoracic index. — Hum. Biol., *27;* 65.

URIST, M. R.—GURNEY, M. S.—FAREED, D. O. (1970): Observations on the natural course of the disease and the long-term results of osteoporosis. — *In:* BARZEL, U. S. (Ed.): *Osteoporosis*, p. 23. — Grune and Stratton, New York.

Author's address: Prof. Dr. LAKHMIR S. SIDHU
Dr. PUSHPA SINGAL
Dept. Human Biology, Punjabi University
Patiala — 147002
India

Anthrop. Közl. *24;* 223–234. 1980.

ESTIMATION OF BODY VOLUME AND BODY DENSITY FROM LEG DIMENSIONS IN PUNJABI GIRLS

by R. Singh and C. Raja
(Department of Anthropology, University of Delhi, Delhi, India)

A b s t r a c t. Mean values and standard deviations of total body volume, body density, leg volume, stature, weight and a battery of 24 leg measurements of 200 Punjabi girls aged 10–19 years are presented. Relationships between leg volume and total body volume in different age groups are also reported. Highly significant and positive correlations exist between leg volume and total body volume and the values of correlation coefficients ranged between 0.78 to 0.94 in different age groups.

Body volume was also estimated from leg dimensions by selective stepwise multiple linear regression analysis. Highly significant multiple correlation coefficients were obtained for predicting total body volume from leg dimensions, and their values ranged between 0.92 to 0.98 in different age groups with a combination of just three or four leg measurements. The most commonly selected measurements up to the 4th step in most of the age-groups were maximum thigh girth and maximum calf girth.

Body density was estimated from simple leg dimensions again by using selective stepwise multiple linear regression analysis and the multiple 'R' ranged between 0.64 to 0.91 in different age groups.

In addition, multiple correlation coefficients between leg volume on the one hand and different combinations of leg dimensions on the other are presented separately in different age groups.

Key words: physique, body composition, body volume, body density, leg dimensions, Punjabi girls.

Introduction

A number of reports are available on body volume and body density of adults and adolescents of diffrent populations (Pařízková and Eiselt 1968, Pařizková 1970, Pařízková and Buzkova 1971, Gopalan et al. 1955, Katch and Michael 1968, Katch and McArdle 1973, Katch and Weltman 1975, Durnin and Rahaman 1967, Wilmore and Behnke 1969, Haisman 1970, Wakat et al. 1971, Pollock et al. 1976, Young et al. 1968, Smith and Boyce 1977, Sen and Banerjee 1958, Raja et al. 1977, 1978, Raja and Singh 1978a, 1978b, Singh and Raja 1979) but information on the relationship of body volume and body density with leg volume in Indian girls is sparse. Also information on the relationship of simple leg dimensions with body volume and body density has been rather scanty. The aim of the present study is, therefore, to report on the relationship of the leg volume as well as simple leg dimensions with total body volume and body density of Indian girls of different age-groups. Also the relative importance of different leg dimensions for estimating body volume and body density by using selective stepwise multiple linear regression analysis in different age-groups is stressed.

Material and Methods

Two hundred Punjabi (Indian) girls aged 10—19 years from the city of Delhi were experimentally measured for total body volume, leg volume, body density and a series of 24 leg dimensions.

Body volume measurement

Body volume was measured in each subject with JONES' (1972) water displacement technique. Vital capacity and residual lung volume were measured while the subject was submerged chin-deep in water. Both vital capacity and residual lung volume were subtracted from the body volume so as to get corrected body volume (hereafter called total body volume).

Table 1

Reliability coefficients of different measurements

Variables	Error in per cent
Body volume	1.2
Body density	1.4
Body weight	1.3
Stature	0.2
Total leg length	2.7
Height up to gluteus furrow	3.3
Height up to maximum thigh	3.1
Height up to 1/3 subischial thigh	3.0
Height up to lower thigh	4.1
Length of lover leg	2.3
Height up to upper calf	4.0
Height up to maximum calf	2.6
Height up to minimum ankle	1.9
Foot length	1.2
Foot girth	2.6
Gluteal furrow girth	3.3
Maximum thigh girth	2.6
1|3 subischial thigh girth	3.3
Lower thigh girth	3.2
Knee-joint girth	1.2
Upper calf girth	1.8
Maximum calf girth	2.9
Ankle girth	2.9
Knee diameter	2.5
Elbow diameter	2.3
Anterior thigh skinfold	3.1
Posterior thigh skinfold	3.7
Posterior calf skinfold	3.2

Leg volume measurement

Leg volume was measured using a locally fabricated leg volumeter (RAJA et al. 1977).

Anthropometry. A battery of 24 leg dimensions, namely total leg length, height up to gluteus furrow, height up to maximum thigh, height up to 1/3 sub-ischial thigh, height up to lower thigh, lower leg length, height up to upper calf, height up to maximum calf, height up to minimum ankle, foot length, foot girth, gluteus furrow girth, maximum thigh girth, height up to 1|3 sub-ischial thigh girth, lower thigh girth, knee-joint girth, upper calf girth, maximum calf girth, ankle girth, knee diameter, ankle diameter, anterior thigh skinfold, posterior thigh skinfold and posterior calf skinfold were taken of each subject. In addition, also height and body weight were recorded for each subject the techniques followed for taking the measurements were those of TANNER et al. (1969).

Reliability of measurements. Before starting the experiment, all measurements were standardized and the reliability of body volume, leg volume, body density, height, weight and all 24 leg dimensions was ascertained by repeating the experiments on 25 subjects on two different occasions. The error in per cent in the measurement of every variable was less than 5% (Table 1).

Results and Discussion

The mean values and standard deviations of the leg dimensions, leg volume, body volume, and body density are given in Table 2. Also the means and SDs of height and weight are included in Table 2.

Relationship between leg volume and body volume. Scatter graphs showing the relationship between leg volume and body volume along with regression equations for determining body volume from leg volume are given in Fig. 1 to 10. Very high and positive linear relationship existed between leg volume and total body volume in all age groups and the values of correlation coefficient 'r' ranged between 0.78 to 0.94 in the various age groups. In most of the age groups, the value of 'r' was very high, and in the 11 year age group, the value of 'r' was as high as 0.94. Standard errors of the estimation of body volume from leg volume ranged between 1.73 to 4.03 litres in different age groups (Table 3).

Estimation of leg volume from leg dimensions. Sometimes leg volume measurements are not so practical in the field as in the laboratory. Therefore, attempts were made to estimate leg volume from more easily practicable simple leg dimensions. Selective stepwise multiple linear regression analysis was done for this purpose. Very high and highly significant multiple correlation coefficients 'R' were obtained between leg volume and different combinations of leg dimensions at different steps in the various age groups; presently only the values of 'R' and regression equations at the 4th step alone are given (Table 4). The values of 'R' at the 4th step ranged between 0.91 to 0.98 in the various age groups. Knee-joint girth and maximum calf girth were the most commonly selected measurements in the age groups (Table 4). These observations are most interesting and suggest that simple leg dimensions may be used for estimating leg volume.

Table 2

Mean values and standard deviations of different measurements in different age groups 1

Measurements	10 year n = 20	11 year n = 20	12 year n = 20	13 year n = 20	14 year n = 20	15 year n = 20	16 year n = 20	17 year n = 20	18 year n = 20	19 year n = 20
Total body volume (Litres)	23.23 ±3.33	26.84 ±4.90	29.52 ±5.44	37.01 ±5.84	41.62 ±6.18	40.03 ±6.70.	46.30 ±6.70	46.30 ±8.66	40.49 ±5.77	41.73 ±5.29
Leg volume (litres)	3.39 ±0.72	4.35 ±1.10	4.65 ±0.91	5.77 ±1.98	7.35 ±1.41	6.63 ±1.26	7.81 ±1.81	6.67 ±0.89	6.95 ±1.34	7.08 ±1.45
Body density (g/ml.)	1.018 ±0.091	1.080 ±0.017	1.070 ±0.019	1.053 ±0.018	1.049 ±0.021	1.061 ±0.024	1.051 ±0.024	1.058 ±0.021	1.056 ±0.024	1.049 ±0.021
Stature (cm)	131.6 ±7.02	136.9 ±6.74	141.0 ±5.99	148.2 ±6.74	154.2 ±5.2	153.2 ±4.34	146.3 ±4.9	154.3 ±4.5	151.6 ±5.9	151.2 ±5.1
Body weight (kg)	25.1 ±3.5	28.9 ±5.1	31.5 ±5.2	38.9 ±5.9	43.8 ±5.8	42.4 ±6.4	48.4 ±8.3	42.8 ±5.7	44.0 ±5.1	44.0 ±6.3
Total leg length (cm)	80.2 ±5.2	83.6 ±4.5	86.1 ±3.9	89.6 ±4.6	94.0 ±4.0	92.9 ±3.3	94.6 ±3.8	93.0 ±3.8	91.2 ±3.9	92.2 ±3.5
Height up to gluteus fold (cm)	60.7 ±4.3	64.0 ±3.7	65.2 ±3.3	68.4 ±4.3	72.0 ±3.7	70.4 ±3.0	71.0 ±3.7	69.6 ±3.2	68.3 ±3.4	69.4 ±3.2
Height up to maximum thigh (cm)	56.6 ±3.8	59.3 ±3.8	60.5 ±3.0	64.0 ±4.1	67.3 ±3.4	65.8 ±2.5	66.2 ±4.1	65.0 ±2.9	64.5 ±3.4	63.7 ±3.2
Height up to 1/3 subischial thigh (cm)	51.1 ±3.2	53.5 ±3.6	54.5 ±3.1	57.6 ±3.6	60.8 ±3.9	60.1 ±3.3	59.7 ±3.5	58.6 ±3.5	56.9 ±3.1	56.8 ±3.4
Height up to lower thigh (cm)	45.2 ±3.0	47.5 ±3.3	48.1 ±2.8	51.5 ±3.4	53.7 ±3.1	53.2 ±2.9	52.7 ±3.0	52.1 ±2.9	50.4 ±2.5	49.8 ±2.9
Lower leg length (cm)	37.0 ±2.2	38.9 ±2.3	39.6 ±2.1	42.5 ±2.5	43.9 ±2.3	43.7 ±2.8	44.0 ±2.7	43.1 ±1.9	42.7 ±2.1	42.7 ±2.3
Height up to upper calf (cm)	32.0 ±2.1	33.4 ±2.0	34.6 ±2.0	37.0 ±2.6	38.7 ±2.3	37.7 ±2.2	38.4 ±2.7	37.7 ±2.0	37.2 ±2.4	36.6 ±2.1
Height up to maximum calf (cm)	26.6 ±1.6	27.5 ±1.8	28.5 ±1.6	31.5 ±2.2	32.9 ±2.5	32.3 ±1.8	31.7 ±1.6	31.4 ±1.9	30.9 ±2.3	31.0 ±1.6

Height up to minimum ankle (cm)	10.0 ±0.7	10.2 ±0.6	10.7 ±0.8	11.5 ±0.9	11.8 ±1.4	10.8 ±0.8	10.8 ±0.9	10.6 ±0.7	10.5 ±0.9	10.6 ±0.7
Foot length (cm)	20.6 ±0.9	21.5 ±0.8	21.9 ±1.1	22.7 ±0.9	23.1 ±1.0	22.8 ±1.1	23.6 ±1.2	23.4 ±0.8	23.2 ±1.4	22.9 ±1.0
Knee diameter (cm)	7.9 ±0.4	8.3 ±0.6	8.4 ±0.6	9.3 ±0.6	9.5 ±0.7	9.3 ±0.8	10.0 ±1.2	9.2 ±0.9	9.4 ±0.6	9.3 ±0.9
Ankle diameter (cm)	5.6 ±0.4	5.8 ±0.3	5.8 ±0.3	5.1 ±0.2	6.2 ±0.2	6.0 ±0.4	6.1 ±0.3	5.9 ±3.4	6.2 ±0.3	6.0 ±0.4
Gluteal girth (cm)	37.5 ±2.9	40.2 ±4.0	42.2 ±4.0	46.4 ±4.3	48.0 ±5.0	47.3 ±4.7	52.5 ±5.7	48.6 ±3.9	49.1 ±4.5	48.6 ±5.2
Maximum thigh girth (cm)	36.4 ±2.7	39.0 ±4.0	40.8 ±4.0	44.5 ±4.0	46.2 ±5.9	45.6 ±4.5	50.9 ±6.4	47.6 ±4.0	47.6 ±4.0	47.3 ±5.1
1/3 subischial thigh girth (cm)	31.4 ±2.6	34.7 ±3.6	35.8 ±2.6	37.8 ±3.5	39.9 ±4.7	39.1 ±3.7	41.9 ±5.9	39.5 ±3.7	40.8 ±3.1	40.9 ±4.5
Lower thigh girth (cm)	26.7 ±2.0	29.2 ±3.1	29.1 ±2.9	31.9 ±2.7	34.1 ±3.5	32.9 ±2.7	36.3 ±4.4	33.5 ±3.2	33.4 ±2.5	33.9 ±3.9
Knee-joint girth (cm)	27.1 ±1.7	29.1 ±2.1	29.2 ±2.7	31.1 ±2.1	32.3 ±2.3	32.0 ±1.9	33.8 ±2.9	32.2 ±2.1	32.2 ±1.8	32.0 ±3.0
Upper calf girth (cm)	24.1 ±2.0	26.2 ±3.6	26.0 ±1.6	28.1 ±1.9	29.3 ±2.1	28.8 ±2.0	30.7 ±2.7	29.2 ±2.3	28.4 ±2.4	28.6 ±2.0
Maximum calf girth (cm)	23.4 ±1.8	25.1 ±2.2	25.8 ±1.4	28.3 ±2.3	29.7 ±2.1	29.0 ±2.0	30.7 ±3.0	29.1 ±2.6	29.6 ±1.8	29.2 ±2.4
Ankle girth (cm)	16.5 ±1.3	17.9 ±1.5	18.1 ±1.1	19.0 ±1.5	19.7 ±1.5	19.7 ±1.1	20.3 ±1.2	19.9 ±2.1	19.6 ±1.3	19.3 ±1.6
Foot girth (cm)	18.4 ±1.0	19.8 ±1.1	20.0 ±1.1	19.9 ±2.9	19.3 ±3.0	19.0 ±3.1	21.5 ±1.7	21.5 ±1.3	22.0 ±1.2	21.6 ±1.3
Anterior thigh skinfold (mm)	15.3 ±2.7	16.6 ±5.2	19.3 ±6.2	22.0 ±6.2	26.1 ±5.9	23.7 ±7.7	27.9 ±8.0	23.6 ±5.9	24.9 ±7.3	26.3 ±6.6
Posterior thigh skinfold (mm)	22.4 ±7.7	22.3 ±5.4	26.2 ±6.7	31.2 ±7.7	25.2 ±7.9	32.8 ±9.5	37.0 ±11.9	31.1 ±7.4	33.6 ±7.5	35.9 ±7.5
Posterior calf skinfold (mm)	13.1 ±2.9	16.6 ±4.3	18.0 ±5.8	22.4 ±5.9	25.2 ±7.6	19.6 ±6.2	23.8 ±7.7	20.3 ±6.3	17.4 ±5.9	19.5 ±6.1

Table 3

Estimation of total body volume (y) from leg volume (x)

Age groups (year)	Regression equation for predicting body volume (y) from leg volume (x)	Correlation coefficient (r)	Standard error of estimate (litres)
10	y = 11.083 + (3.587) x	0.78	2.17
11	y = 8.587 + (4.194) x	0.94	1.73
12	y = 5.778 + (5.111) x	0.86	2.85
13	y = 16.383 + (3.262) x	0.91	2.44
14	y = 13.748 + (3.793) x	0.87	3.16
15	y = 10.198 + (4.502) x	0.84	3.70
16	y = 12.141 + (4.373) x	0.91	3.62
17	y = 8.996 + (4.602) x	0.88	2.80
18	y = 19.006 + (3.268) x	0.83	3.50
19	y = 15.792 + (3.701) x	0.81	4.03

Estimation of total body volume from leg dimensions. As the multiple correlation coefficients 'R' for estimating leg volume from leg dimensions were very high (Table 4), also an attempt was made to estimate total body volume from leg dimensions using selective stepwise multiple linear regression analysis. Highly significant multiple correlation coefficients 'R' were obtained between the total body volume and various combinations of leg measurements at different steps in different age groups, however, in this paper, values of 'R' regression equations and standard errors of estimate are given only at the 4th step (Table 5). The values of 'R' at the 4th step ranged between 0.92 to 0.98 in the different age groups. The most commonly selected leg dimensions up to the 4th step in the different age groups were maximum thigh girth and maximum calf girth (Table 5).

It is interesting to observe that total body volume can be estimated from a set of just two to four leg measurements alone.

On closer observation of Tables 3 and 5 it was noteworthy that an appropriate combination of just three or four simple leg dimensions gave higher values of 'R' and lower values of standard error of estimate for estimating the total body volume than the leg volume measurements for estimating that volume.

Estimation of body density from leg dimensions. Attempts were also made to estimate body density from leg dimensions using selective stepwise multiple linear regression analysis. Highly significant multiple 'R' values between body density and different combinations of leg dimensions were obtained at different steps in different age groups but only the values of 'R', regression equations and standard error of estimate at the 4th step are given here (Table 6). The values of multiple 'R' at the 4th step ranged between 0.64 to 0.92 in the various age groups. In most age groups the value of 'R' was above 0.81. The most frequently selected measurement up to the 4th step in the different age groups was calf girth. Thus the results presented in this study appear to be of some practical importance.

Table 4

Estimation of leg volume from leg measurements

Age groups (year)	Multiple regression equation for predicting leg volume	Multiple correlation coefficient 'R'	Standard error of estimate 'litres'
10	Leg volume = 9.381 + (0.468) Lower thigh girth −(0.173) Posterior calf skinfold +(0.488) Foot girth − (0.238) Knee joint girth	0.94	0.269
11	Leg volume = −8.169 + (0.453) Knee-joint girth +(0.151) 1|3 Subischial thigh girth −(0.151) Knee diameter	0.94	0.419
12	Leg volume = −8.456 + (0.077) Gluteal girth + (0.104) Total leg length + (0.046) Anterior thigh skinfold	0.97	0.253
13	Leg volume = −16.107 + (0.198) Lower thigh girth + (0.405) Upper calf girth + (0.249) Ankle girth	0.98	0.378
14	Leg volume = −10.017 + (0.160) Maximum calf girth + (0.270) Knee-joint girth + (0.058) Anterior thigh skinfold + (0.050) Maximum thigh girth	0.94	0.551
15	Leg volume = −12.867 + (0.188) Lower thigh girth + (0.035) Posterior calf skinfold + (0.122) Total leg lengh + (0.551) Anterior thigh skinfold	0.95	0.452
16	Leg volume = −9.490 + (0.434) Maximum calf girth + (0.395) Knee diameter	0.97	0.316
17	Leg volume = −4.157 + (0.082) Lower thigh girth +(0.881) Knee diameter −(0.120) Maximum calf girth + (0.091) 1/3 Subischial thigh girth	0.97	0.316
18	Leg volume = −17.855 + (0.400) Lower thigh girth +(0.253) Height up to gluteus furrow −(0.258) Height up to upper calf +(0.126) Maximum calf girth	0.97	0.353
19	Leg volume = −13.976 + (0.440) Maximum calf girth +(0.395) Minimum ankle girth −(0.115) 1/3 Subischial thigh girth +(0.106) Height up to lower thigh	0.91	0.689

Table 5

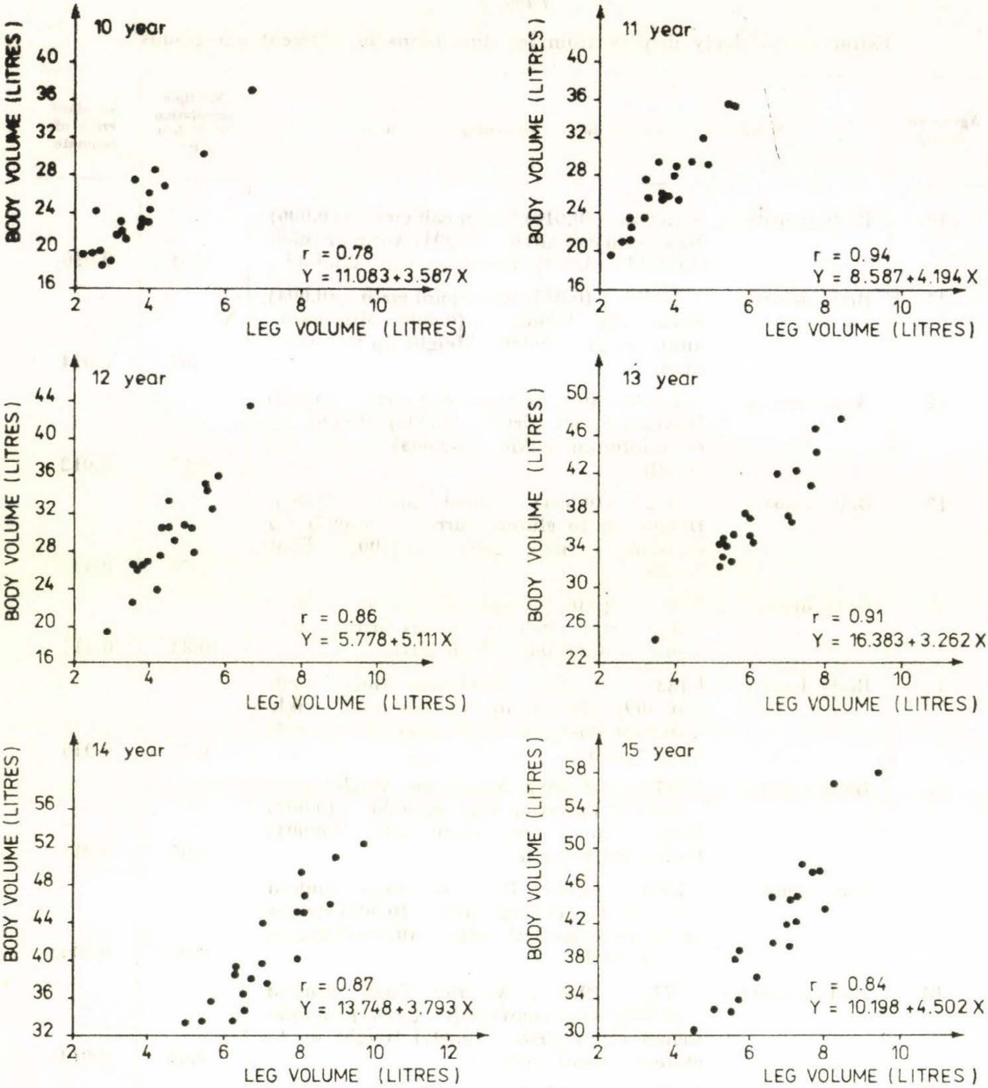
Estimation of total body volume from leg measurements in different age groups

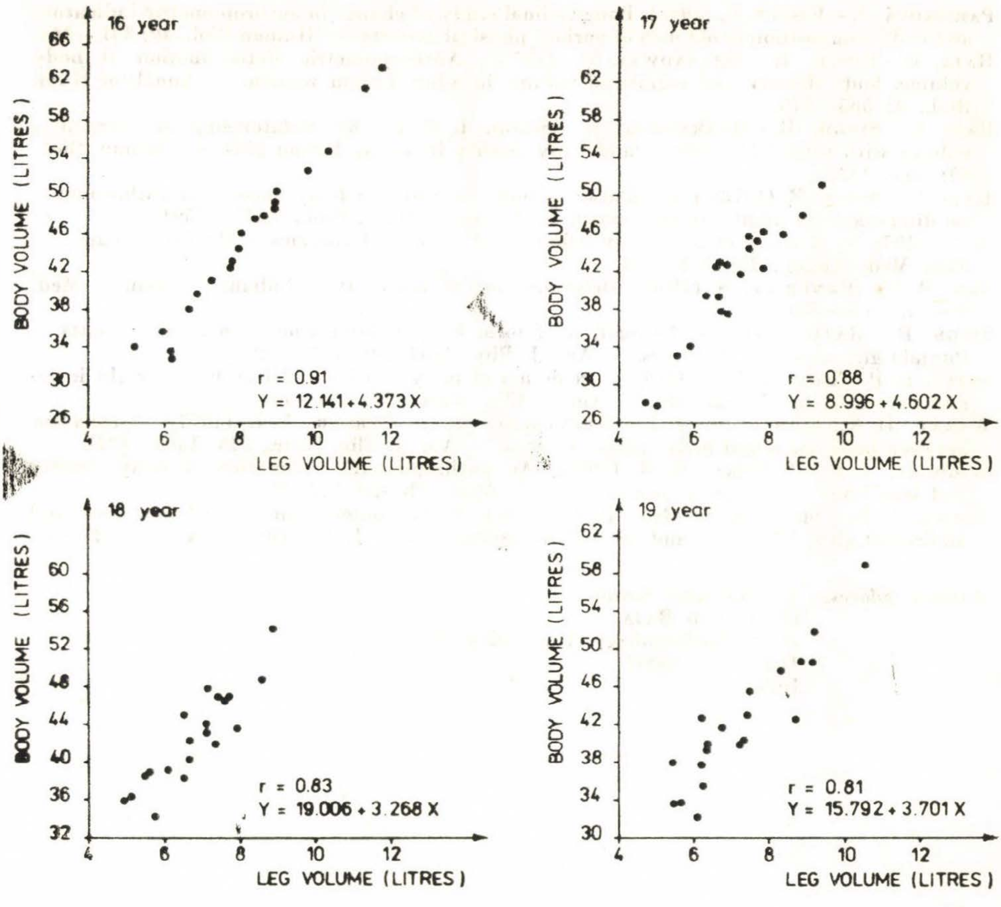
Age groups (year)	Multiple regression equations for estimating body volume	Multiple correlation coefficient 'R'	Standard error of estimate 'litres'
10	Total body volume = −45.864 + (1.144) Knee-joint girth +(2.364) Foot length −(0.609) Height up to lower thigh +(0.304) Height up to maximum thigh	0.98	0.824
11	Total body volume = −43.958 + (1.173) Knee-joint girth +(0.399) 1/3 Subischial thigh girth +(0.803) Total leg length −(1.266) Height up to upper calf	0.97	1.322
12	Total body volume = −55.248 + (0.631) Gluteus furrow girth +(1.312) Foot length +(0.463) Lower thigh girth +(0.555) Height up to maximum calf	0.94	2.078
13	Total body volume = −49.232 + (0.597) Lower thigh girth +(1.569) Maximum calf girth +(0.687) Total leg length −(0.911) Lower leg length	0.97	1.494
14	Total body volume = −34.973 + (1.928) Upper calf girth +(0.181) Anterior thigh skinfold −(0.434) Foot girth +(1.202) Ankle girth	0.92	2.695
15	Total body volume = −24.172 + (1.292) Maximum thigh girth +(0.699) Maximum calf girth −(0.696) Height up to upper calf +(1.054) Height up to minimum ankle	0.98	1.592
16	Total body volume = −44.832 + (2.800) Knee diameter +(0.691) Maximum thigh girth +(4.618) Ankle diameter	0.98	1.792
17	Total body volume = −24.022 + (0.577) Lower thigh girth +(2.693) Knee diameter +(0.426) Maximum thigh girth	0.97	1.482
18	Total body volume = −25.224 +(2.483) Lower thigh girth −(5.008) Knee diameter +(0.893) Hieght up to maximum calf +(0.206) Posterior calf skinfold	0.98	1.213
19	Total body volume = −10.782+(1.394) Maximum calf girth +(0.364) Posterior thigh skinfold +(0.487) Height up to lower thigh −(0.374) Height up to gluteus furrow	0.94	2.586

Table 6

Estimation of body density from leg dimensions in different age-groups

Age-group (year)	Multiple regression equation for estimating body density	Multiple correlation coefficient 'R'	Standard error of estimate
10	Body density = +1.2056 −(0.010) Upper calf girth +(0.006) Maximum calf girth −(0.004) Anterior thigh skinfold +(0.003) Posterior calf skinfold	0.64	0.016
11	Body density = +1.0735 −(0.011) Knee-joint girth +(0.004) Total leg length +(0.006) Minimum ankle girth −(0.003) Height up to lower thigh	0.68	0.014
12	Body density = +1.2504−(0.013) Upper calf girth +(0.004) Maximum calf girth −(0.008) Height up to minimum ankle +(0.003) Lower leg length	0.81	0.012
13	Body density = 0.9592 −(0.004) Gluteal girth +(0.003) Height up to gluteus furrow −(0.007) 1/3 subischial thigh girth +(0.002) Foot length	0.79	0.013
14	Body density = 1.3176 −(0.001) Upper calf girth −(0.006) Ankle girth −(0.005) Gluteus furrow girth +(0.003) Maximum thigh girth	0.84	0.013
15	Body density = 1.1339 −(0.001) Maximum thigh girth +(0.009) Height up to minimum ankle −(0.008) Posterior thigh skinfold −(0.004) Ankle girth	0.77	0.016
16	Body density = 1.0879 −(0.002) Maximum thigh girth −(0.015) Posterior calf skinfold +(0.008) Height up to maximum calf −(0.004) Lower thigh girth	0.85	0.013
17	Body density = 1.1293 −(0.004) Posterior thigh skinfold −(0.010) Lower thigh girth +(0.004) Height up to 1/3 Subischial thigh +(0.004) Gluteus furrow girth	0.92	0.0093
18	Body density = 1.0776 −(0.001) Anterior thigh skinfold +(0.006) Knee-joint girth −(0.001) 1|3 Subischial thigh girth +(0.004) Height up to gluteus furrow girth	0.84	0.014
19	Body density = 1.0948 −(0.013) Upper calf girth +(0.004) Foot length +(0.002) Posterior calf skinfold +(0.002) Total leg length	0.91	0.0099


10 year
BODY VOLUME (LITRES)
r = 0.78
Y = 11.083+3.587 X
LEG VOLUME (LITRES)
11 year
BODY VOLUME (LITRES)
r = 0.94
Y = 8.587+4.194 X
LEG VOLUME (LITRES)
12 year
BODY VOLUME (LITRES)
r = 0.86
Y = 5.778+5.111X
LEG VOLUME (LITRES)
13 year
BODY VOLUME (LITRES)
r = 0.91
Y = 16.383+3.262 X
LEG VOLUME (LITRES)
14 year
BODY VOLUME (LITRES)
r = 0.87
Y = 13.748+3.793 X
LEG VOLUME (LITRES)
15 year
BODY VOLUME (LITRES)
r = 0.84
Y = 10.198+4.502 X
LEG VOLUME (LITRES)



REFERENCES

DURNIN, J. V. G. A.—RAHAMAN, M. M. (1967): The assessment of amount of fat in the human body from measurements of skinfold thickness. — Brit. J. Nutr. *20;* 681—689.

GOPALAN, C.—SRIKANTIA, S. G.—VENKATACHALAM, P. S. (1955): Body composition and basal metabolism of normal subjects. — J. Appl. Physiol., *8;* 142—144.

HAISMAN, M. F. (1970): The assessment of body fat content in young men from measurements of body density and skinfold thickness. — Human Biol., *42;* 674—688.

JONES, P. R. M. (1972): A body volumeter to measure human body density. — J. Physiol., *222;* 5—7.

KATCH, F. I.—MICHAEL, E. D. (1968): Prediction of body density from skinfold and girth measurements of college females. — J. Appl. Physiol, *25;* 92—94.

KATCH, F. I.—MCARDLE, W. D. (1973): Prediction of body density from simple anthropometric measurements in college-age men and women. — Human Biol., *45;* 445—454.

KATCH, V.—WELTMAN, A. (1975): Predictability of body segment volumes in living subjects. — Human Biol., *47;* 203—218.

PAŘÍZKOVÁ, J. (1970): Development of lean body mass and fat during growth. — Čes. Pediat., *25;* 469—473.

PAŘÍZKOVÁ, J.—EISELT, E. (1968): Longitudinal study of change in anthropometric indicators and body composition in old men of various physical activity. — Human Biol., *40;* 331—344.
RAJA, C.—SINGH, R.—BHARADWAJ, H. (1977): Anthropometric determination of body volume, body density and segmental volume in adult Indian women. — Annals of Hum. Biol., *4;* 565—575.
RAJA, C.—SINGH, R.—BHARADWAJ, H.—SINGH, I. P. (1978): Relationship of extremity, volume with total body volume and body density in young Indian girls. — Human Biol. *50;* 103—113.
RAJA, C.—SINGH, R. (1978/a): Estimation of body fat and lean body mass from anthropometric dimensions in adult Indian women. — Annals of Hum. Biol., *5;* 591—594.
— — (1978/b): A study of total body volume and segmental volumes in Punjabi females. — Acta Med. Auxol., *10;* 151—162.
SEN, R. N.—BANERJEE, S. (1958): Determination of body fat in Indians. — Ind. J. Med. Res. *46;* 556—560.
SINGH, R.—RAJA, C. (1979): Estimation of total body volume from arm measurements in Punjabi girls aged 10—19 years. — Am. J. Phy. Anth. *50;* 387—392.
SMITH, D. P.—BOYCE, R. W. (1977): Prediction of body density and lean body weight in females from 25 to 37 years old. — Am. J. Clin. Nutr., *30;* 560—564.
WAKAT, D. K.—JOHNSTON, F. E.—KRZYWICKI, H. J.—GERBER, L. I. (1971): Correlation between body mass and body volume in men. — Am. J. Clin. Nutr., *248;* 1308—1312.
WILMORE, J. H.—BEHNKE, A. R. (1969): An anthropometric estimation of body density and lean body weight in young men. — J. Appl. Physiol., *27;* 25—31.
YOUNG, C. M.—SIPIN, S. S.—ROE, D. A. (1968): Body composition of pre-adolescent and adolescent girls. I. Density and skinfold measurements. — J. Am. Dietetic Ass., *53;* 25—31.

Authors' address: Dr. RAGHBIR SINGH
Dr. CHAND RAJA
Dept. Anthropology, University of Delhi
Delhi — 110007
India

Anthrop. Közl. *24;* 235. 1980.

THE MUSCULO-SKELETAL INDEX AS A METHOD OF CHARACTERIZING THE PHYSIQUE OF ATHLETES

by M. H. SLAUGHTER and T. G. LOHMAN

(Physical Fitness Research Laboratory, Department of Physical Education, College of Applied Life Studies, University of Illinois at Urbana, Urbana, Illinois, USA)

A b s t r a c t. The purpose of this paper is to present an objective method for estimating the musculo-skeletal mass in relation to height for use in the study of body physique in athletes. The method can be applied to various male and female athletic groups and indicates the relative musculo-skeletal development by the extent to which each group falls above or below the regression of FFB on height as derived from the non-athletic male and female populations. Athletes within both sexes are found to differ greatly among performance events in this aspect of physique with track runners having the least amount of FFB related to height (within 1 standard error of the non-athletic population regression line) and professional football players having the most (2 to 3 standard errors above the non-athletic population line). Measurement of FFB can be obtained by underwater weighing or anthropometric dimensions and thus this approach offers application to the study and assessment of relative musculo-skeletal development in a variety of laboratory and field settings.

The authors intend to publish their paper elsewhere.

Authors' address: Dr. MARY H. SLAUGHTER
Dr. T. G. LOHMAN
Physical Fitness Research Laboratory
Dept. Physical Education
College of Applied Life Studies
University of Illinois at Urbana
Urbana — Champaign
USA Ill. 61820

Anthrop. Közl. *24;* 237—240. 1980.

SECULAR CHANGE OF BODY SIZE AND FORM OF BLACK AMERICAN CHILDREN AND YOUTHS LIVING IN THE UNITED STATES

by J. H. SPURGEON and H. V. MEREDITH

(College of Health and Physical Education, University of South Carolina, Columbia, South Carolina, USA)

Abstract. During 1974—1977, 1.500 black children and youths of Richland County, South Carolina were measured for standing height, sitting height, hip width, arm girth, calf girth, and body weight. These data were obtained to (a) provide descriptive statistics on body size and body form of United States Southern blacks, and (b) allow comparison of Southern blacks with other groups studied about 1900 in the United States, and since 1960 in many parts of the world.

Compared with black youths measured in the United States at about the turn of the century, present-day youths are considerably larger: girls age 13 years are 10.9 cm taller and 9.9 kg heavier; boys age 15 years, taller by 14.5 cm and heavier by 12.3 kg. These increases closely approximate those of their white peers over the same period.

Richland County black youths have longer lower limbs relative to sitting height than their white peers. Undoubtedly, this relates to the success experienced by black youths in some athletic events.

Key words: Secular change, racial differences, skelic index.

Introduction

Between 1974 and 1977, physical measurements were taken on nearly three thousand black and white children and youths in Richland County, South Carolina. Two of our objectives were (1) revision of American white height-weight school and clinic charts for the National Education Association and the American Medical Association, and (2) development of similar charts for American black children and youths. Additionally, we aimed to secure descriptive statistics on body size and body form of United States Southern blacks, and compare these with statistics of groups studied about 1900 in the United States and since 1960 in other parts of the world (MEREDITH 1976, MEREDITH and SPURGEON 1976, SPURGEON and MEREDITH 1979).

Methods and Materials

The materials used in this paper are measures of standing height, sitting height, and body weight obtained during 1974—1977 on South Carolina black and white female youths age 13 years, black and white male youths age 15 years, and black male youths age 19 years. The measures of standing height and sitting height were used to derive an index of body form, i.e. the *skelic* *index*. In deriving this index (1) lower limb height was obtained as standing height minus sitting height, and (2) lower limb height × 100/sitting height was computed for each subject.

The method is both descriptive and comparative. Means for standing height, body weight, and the skelic index are presented for South Carolina black and white females age 13 years and black and white males age 15 years. Comparison of means for standing height and body weight are made with means from studies reported near 1900. Skelic index comparisons are made for black and white groups.

Results and Discussion

A commonly heard observation is that adults have been getting taller and heavier during the last several generations. This is true to some extent, but the increases are much more dramatic in late childhood and early adolescence than in adulthood. Table 1 compares the black and white youths studied in South Carolina with black and white youths studied in the United States in the 1890's.

Table 1

Average height and weight of United States youths in two secular periods

Date	Height (cm)	Weight (kg)	Date	Height (cm)	Weight (kg)
Black Females Age 13 Yrs.			*White Females Age 13 Yrs.*		
1896–97	145.8	39.0	1875–80	145.3	36.7
1974–77	*156.7*	*48.9*	1974–77	*156.4*	*47.3*
Increase	10.9	9.9		11.1	10.6
Black Males Age 15 Yrs.			*White Males Age 15 Yrs.*		
1896–98	152.7	44.3	1892	154.9	45.4
1974–77	*167.2*	*56.6*	1974–77	*169.4*	*57.1*
Increase	14.5	12.3		14.5	11.7

Utilizing two age groups, the black girls measured in 1974—1977 are 10.9 cm taller and 9.9 kg heavier than those measured during 1896—1897. The white girls of 1974—77 are 11.1 cm taller and 10.6 kg heavier than those measured between 90 and 100 years earlier. The black boys measured in 1974—1977 are 14.5 cm taller and 12.3 kg heavier than those measured near the turn of the century and the white boys measured in 1974—1977 are 14.5 cm taller and 11.7 kg heavier than those measured 83 years earlier. Obviously the increases are quite similar over approximately the same period.

Of interest is what has caused these increases. The answers most often heard are better nutrition, vitamins, better prenatal and postnatal medical care, improved housing, adequate clothing, etc. However, these responses pose problems. Quantitatively it is not possible to determine where the effect of better nutrition leaves off and improved medical care begins. Also no disinterested observer would suggest that black children have had as good a "growth environment" in Richland County during the last 75 years as have white children, yet their increases in height and weight are quite similar.

It has been suggested that these environmental influences have been cumulative. This sounds reasonable except that secular increases are now being observed in many of the developing nations of the world where living conditions are far from optimal. The fact is, as current authorities have stated, the reasons for secular increases are not well understood (CONE 1961, MEREDITH 1976, TANNER 1966, VLASTOVSKY 1966).

A phenomenon of the American sports world since World War II has been the emergence of the black athlete. Many reasons for his success have been suggested, among them social, cultural, economic, and even anthropometric differences. Unquestionably there are anthropometric differences that are advantageous in certain sports such as basketball and track and field, and one difference is the relation of lower limb length to sitting height i.e., the skelic index. If everything else is equal in two men of the same height the man with the highest skelic index will jump highest because his crotch is higher off the ground. We found this relationship to exist between the 13 year old girls and 15 year old boys.

The black girls have about a 5 percentage point advantage and the black boys a 6 to 7 percentage point advantage.

Among the white females one subject only had a skelic index above 100, 15 of the black females exceeded 100. Among the white males, 4 subjects had skelic indexes above 100, 74 of the black males exceeded 100 (Table 2).

Table 2

Skelic index statistics (%) for United States black and white youths measured 1974—1977

13 year old girls						
	N	Mean	P_5	P_{25}	P_{75}	P_{95}
Black	201	93.2	85.5	89.9	96.7	100.7
White	185	88.0	80.0	84.7	90.7	95.9
15 year old boys						
	N	Mean	P_5	P_{25}	P_{75}	P_{95}
Black	219	97.7	88.7	94.4	101.5	105.7
White	186	91.1	82.3	87.3	94.4	98.7

Some years ago, we measured 15 black members of the state 24-man all-star basketball team. These players had been rated by the coaches and considered to be the states' best.

As noted in Table 3, 8 of the 15 young men matriculated at two- or four-year colleges. Player number one became an outstanding member of one of the nation's best teams.

One of our finest professional basketball players is David Thompson who is 193 cm. and has a skelic index of 115. One can well understand why he has such great jumping ability. Some observers have suggested that the black

Table 3

Skelic indicies of 15 black high school all-star basketball players

Subject	Skelic Index	Subject	Skelic Index
*1	114	9	99
*2	107	10	99
*3	105	11	98
*4	104	12	97
*5	101	13	95
*6	100	14	95
*7	100	15	95
*8	100		

Average for group = 101
* Matriculated at two and four year colleges

athlete's success in sports is based almost entirely upon desire. We would suggest that in addition to desire, ability and appropriate physique are also important.

REFERENCES

CONE, T. E. JR. (1961): Secular acceleration of height and biologic maturation in children during the past century. — Journal of Pediatrics, *59;* 736—740.

MEREDITH, H. V. (1976): Findings from Asia, Australia, Europe, and North American on secular change in mean height of children, youths, and young adults. — Am. J. Phys. Anthrop. *44;* 315—326.

MEREDITH, H. V.—SPURGEON, J. H. (1976): Comparative findings on the skelic index of black and white children and youths residing in South Carolina. — Growth, *40;* 75—81.

SPURGEON, J. H.—MEREDITH, H. V. (1979): Body size and form of black and white male youths: South Carolina youths compared with youths measured at earlier times and other places. — Human Biology, *51;* 187—200.

TANNER, J. M. (1966): The secular trend towards earlier physical maturation. — Tijdschrift Voor Sociale Geneeskunde, *44;* 524—539.

VLASTOVSKY, V. G. (1966): The secular trend in the growth and development of children and young persons in the Soviet Union. — Human Biology, *38;* 219—230.

Author's address: Prof. Dr. JOHN H. SPURGEON
Prof. Dr. HOWARD V. MEREDITH
College of Health and Physical Education
University of South Carolina
Columbia,
U.S.A. South Carolina 29208

Anthrop. Közl. *24;* 241–246. 1980.

COMPARISON OF THE BLAŽEK AND HEATH–CARTER METHODS OF SOMATOTYPING CHILDREN

by J. Štěpnička

Faculty of Physical Education and Sport, Charles University, Prague, Czechoslovakia)

Abstract. For somatotyping children, the following two methods are often used in Czechoslovakia; Blažek's method characterized by width and robustness of physique as well as by nutritional status and expressed by three numerals, further the Heath–Carter method often described in the literature. The author has compared the two methods as he wanted to find out the advantages and/or disadvantages of each. Both methods have been applied with a group of 10 year old boys. The Blažek method is applicable with children up to the age of 18. The advantages of this method lie in the simplicity of measurement so that the results can be calculated very quickly. Blažek intended to use his method first of all in pediatric practice. The author found the following disadvantages: rating of the third characteristic (nutritional status) rests on a subjective evaluation and there is only a five degree scale at disposal. Heath–Carter's anthropometric method is more accurate, fit for being used with young people. There are problems in the Heath–Carter method especially in evaluating the biepicondylar diameter of the femur of small boys (aged 3–6) and the skinfolds.

According to the author's findings the Blažek method lends itself to be used with small children up to the age of 6–8, for rough and quick information, while the Heath–Carter method is applicable with older children (from the age of 7) and for more accurate rating.

Key words: somatotype, Blažek's somatotype method, Heath–Carter's somatotype method.

Introduction

Biotypological approaches have been less elaborated with children than with adults. This fact has been substantiated by the unability to carry out typological categorization because of unsufficient ripeness of the tissue systems; a further difficulty was found in the changes which the child organism goes through in the course of its development. However, if we proceed from the fact that it is phenotype what we find out with children, the mentioned objections are unsubstantial.

A number of authors have dealt with the proportions of the child, with numerous indices rated from anthropometry or in phenotypical approaches, still, the number of these authors is lower than that of those dealing with the biotypology of the adult population. As an example Stratz, Schlesinger, Liefman, Peterson, Kotulán, Blažek, Heath and Carter etc. could be mentioned.

The author has concerned himself rather deeply with the approaches mentioned last and, therefore, has decided to work out a comparative study of the methods of these authors. Thus his task was to compare BLAŽEK's method of rating children's types and anthropometric somatotyping according to HEATH—CARTER, so that the advantages and/or disadvantages of these methods can be presented.

Material and Methods

Anthropometric somatotype according to HEATH—CARTER which is being compared with BLAŽEK's method here, need not be described, as it has been sufficiently characterized both in original (HEATH—CARTER 1967, CARTER 1975) and in the Czechoslovak literature (ŠTĚPNIČKA et al. 1976, 1979).

BLAŽEK's method of children's biotype measurement has been described only in Czechoslovak literature (BLAŽEK 1970a, 1970b, 1971) and, therefore, the author seems it necessary to introduce it to the reader. Dr. BLAŽEK was a professor of pediatry at Charles University, Prague; his method lies in measuring body width, body robusticity and determining the nutritional state. He recommended the use of his method especially in clinical and preventive medicine.

According to BLAŽEK somatotype is defined as "a spacial composition of the body given by length, width and depth measures. In its constitution the skeleton, subcutaneous fat, the size of the body cavities and of the organs situated in them take part" (BLAŽEK 1971).

BLAŽEK's child somatotype is determined by the following three characteristics: body width, body robusticity and nutritional state. For rating the first characteristic (body width), an index is used which is expressed by the relation of *distantia bideltoidea* to body height. Bideltoidal width is measured with the lower part of the anthropometer. The index is calculated as follows:

$$\frac{\text{distantia bideltoidea} \times 100}{\text{body height}}$$

As for the second characteristic, i.e. body robusticity, thigh circumference is measured by means of metal anthropometric tape. The index is calculated according to the following formula:

$$\frac{\text{thigh circumference} \times 100}{\text{body height}}$$

The third characteristic expresses nutritional state. While the first two characteristics are objectively rated, the third one is of a rather subjective nature as it approaches the evaluation of nutritional state by means of aspexis. Nutritional state is evaluated according to the amount and dispersion of subcutaneous fat. The evaluation of subcutaneous fat gives information on the nutritional condition of the child, on the balance of its caloric and motor balance. For the evaluation of the share of fat, the author worked out a diagnostic method, which has proved to be useful in practice. It is evaluated according to the following respects:

A newborn baby has the layer of fat evenly dispersed all over its body. From its first year when the motor activity of the child increases, the layer

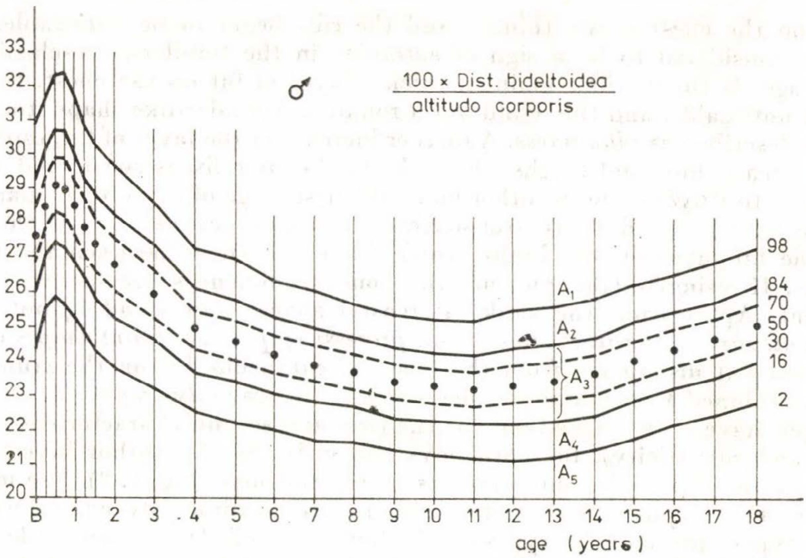


Fig. 1: The first characteristic of BLAŽEK's method

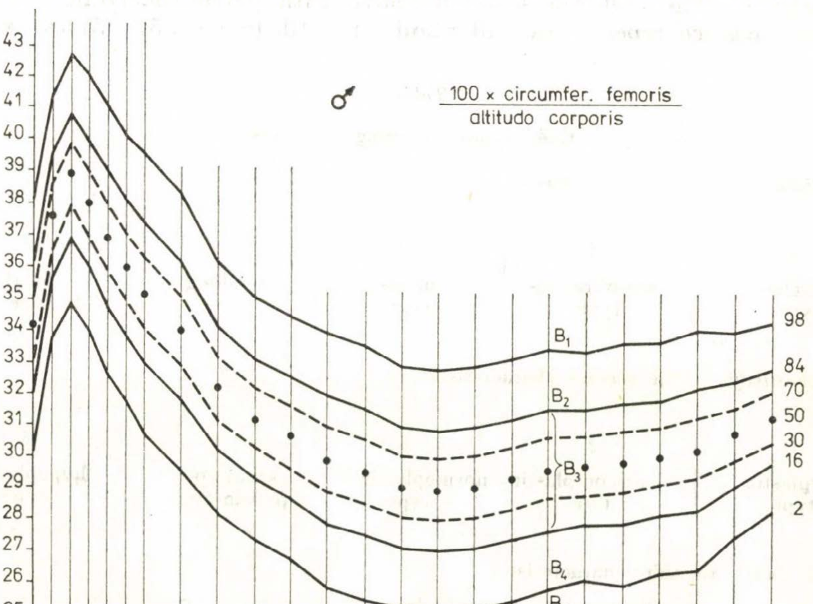


Fig. 2: The second characteristic of BLAŽEK's method

of fat on the chest grows thinner and the ribs begin to be noticeable. This state is considered to be a sign of *eutrophy*, in the toddler-, preschool- and school age. If there still remains a thicker layer of fat on the chest, the ribs are not noticeable, and the child has a rounded, cylinder-like shape, then this state is described as *plumpness*. A further increase of the layer of fat, especially on the breast, hips and thighs where the fat forms rolls, is considered *obesity* according to Blažek. On the other hand, the first stage of *hypotrophy* manifests itself by more marked intercostal spaces and *spina iliaca ant. sup.* At the same time the fat layer on the limbs grows thinner, a space between the thighs appears. If losing weight goes on, the bone prominences become even more apparent. Apart from the sunk intercostal spaces and standing out *spina iliaca ant. sup.*, *spina iliaca post. sup.*, *processi spiposi* and *joint shapes* can be observed. Fat disappears from the face, subcutaneous fat on the trunk and limbs is thinned to a maximum degree. This is grave *dystrophy*.

Graphs have been worked out for the first and second characteristics (body width and robusticity), for both boys and girls. As the author investigated only a group of boys, he only presents graphs for boys (Fig. 1, 2). The marked zones in the graphs differentiate children into medium, strong, robust and gracile types, intermediate types can be found as well. It is a percentile distribution, where the children between the 16th and 84th percentiles (i.e. in Figure 1 the zone A3, in Figure 2 the zone B3) are considered to be at *medium proportions*. The children between the 84th and 98th percentiles (in the graphs the zones A 2, B 2) are considered to be *mesosomes* with signs of *brachytypes*. The children between the 2nd and 16th percentiles are *mesosomes* with signs of *longitypes*. The children situated above 98th percentile (zone A 1, B 1) are extreme *brachytypes*, those under 2nd percentile (zone A 5, B 5) are extreme

Table 1

Child types according to Blažek

Body width — the first characteristic

1	2	3	4	5
brachy-type	mesobrachy-type	meso-type	mesolongi-type	longi-type

Body robusticity — the second characteristic

1	2	3	4	5
hyperplastic type	semihyperplastic type	normoplastic type	semihypo-plastic type	hypoplastic type

Nutrition state — the third characteristic

1	2	3	4	5
obese type	plump type	eutrophic type	hypotrophic type	dystrophic type

longitypes. Founded on rating the three characteristics, the children are included in a certain type as presented in Table 1. All three characteristics are divided on a five-point scale and expressed by Arabic numerals, so that various numeric combinations (e.g. 3—4—3) could be expressed.

Both methods were applied in a group of ten-year-old boys (n = 17). Individuals (boys) of various age-groups were measured besides by means of both methods, so as to verify the author's conclusions.

Results and Discussion

In this rather brief paper the author himself limits only to a general comparison of both applied methods and to point out their advantages or disadvantages.

With boys of ten it appeared in several cases that the lower was the first characteristic of BLAŽEK's method, the higher was the endomorphy component of the HEATH—CARTER's method. The second characteristic of BLAŽEK's method (robusticity) is not a single representative of mesomorphy, the medium types of BLAŽEK (normoplastics) have medium ratings is mesomorphy according to the HEATH—CARTER's method. Hypoplastics have low mesomorphy rating. State of nutrition partly agrees with ectomorphy rating. The lower the nutritional state, i.e. the fatter the child, the lower is the ectomorphy rating.

From the analysis it can be concluded that the two methods differ considerably. While with the HEATH—CARTER's method the endomorphy and ectomorphy component correlate negatively, with the BLAŽEK's method the mentioned characteristics complement each other and correlate positively. The slimmer the child is the higher the characteristics are numerically, and the other way round. Thus it seems that it would be sufficient to measure just one of the first two characteristics, or to rate nutrition state for a more detailed characteristics. Or again, it would be possible to express the BLAŽEK's type by one numeral or expression only. For example among the groups of children we never found a type 5—1—1 (longitype hyperplastic obese) or 1—5—5 (brachytype hypoplastic hypotrophic). The most frequent types (according to BLAŽEK) found were 3—3—3 (29.4%), 2—3—3 and 1—2—2. On the other hand, in the same group we found the following types (according to HEATH—CARTER's method): the most frequent somatotype was 1—4.5—4 (17.7%), as well as 2—4.5—3.5.

The advantages of BLAŽEK's method lie in the simplicity of measurement. The method is suitable for pediatricians and, according to BLAŽEK, its application can have good results in the prevention of obesity. A further advantage: this method is detailed for children from the time of birth till 10 years of age. The rating of the final type is, however, as compared to the HEATH—CARTER's method, rather approximate and less exact. Besides especially as regards the third characteristic, mistakes cannot be excluded (reliability is low).

In contradistinction to BLAŽEK's method, the HEATH—CARTER anthropometric method has the advantage of eliminating the subjective factor as far as possible, with its use the expression of somatotype by means of three numerals is quite clear, well expressible in a somatochart and with sufficient accuracy to cover the whole range of morphological variations. A further well-known advantage is that the rating scales are not limited, which permits a more accurate rating of the somatotype of even extremely developed subjects.

BLAŽEK's intention was to make the type rating of children part of the clinical examination in child welfare centres, health centres and to apply it with sick children. Therefore, he deliberately chose a simple and easy method that could be used by all pediatricians.

According to our findings, the *Blažek method* is suitable to be used with small children up to the age of 6—8 for a rough quick orientation, the HEATH—CARTER's method for a more accurate rating.

REFERENCES

BLAŽEK, F. (1970a): Somatotyp v dětském věku. — Pokroky v pediatrii, *2;* 98—113.

— (1970b): Somatoskopická diagnostika v klinické typologii dítěte. Českosl. Pediatr., *25;* 12, 585—586.

— (1971): Růst a vývoj dítěte. — Českosl. Pediatr. *26;* 317—321.

CARTER, J. E. (1975): *The Heath-Carter Somatotype Method.* San Diego.

HEATH, B. H.—CARTER, J. E. (1967): A Modified Somatotype Method. — Am. J. Phys. Anthrop., *27;* 57—74.

ŠTĚPNIČKA, J. et al. (1976): *Somatotyp, držení těla, motorika a pohybová aktivita mládeze.* — Univerzita Karlova, Praha. 93.

ŠTĚPNIČKA, J.—CHYTRÁČKOVÁ, J.—KASALICKÁ, V.—KUBRYCHTOVÁ, I. (1979): *Somatické předpoklady ke studiu tělesné výchovy.* — Univerzita Karlova, Praha, 115.

Author's address: Dr. JIŘÍ ŠTĚPNIČKA
Faculty of Physical Education, Charles University
Újezd 450
11807 Praha 1
Czechoslovakia

Anthrop. Közl. 24; 247–261. 1980.

EARLY FEEDING PATTERNS, GROWTH AND THE AGING PROCESS

by W. A. STINI

(Department of Anthropology, University of Arizona, Tucson, Arizona, USA)

Abstract. In recent years, significant increases in life expectancy have occurred. This increase has been most pronounced among females. As a result, there were 156 women for every 100 men over age 75 years in the U.S.A. in 1970. The sexual disparity in life expectancies has increased throughout this century. The reasons for this trend are unknown.

Males experience higher mortality rates to both infectious and degenerative diseases. The prognosis for a male patient is generally poorer no matter what stage of the disease at the time of diagnosis or the course of treatment.

It has been shown that the early stages of male growth and development are more susceptible to external perturbations. Thus, growth-maximizing diets have their greatest impact on male children. The connection between male responsiveness to environmental influences during early growth and vulnerability in the later years is significant to the understanding of the aging process.

Key words: Nutrition, growth, aging.

Introduction: Increasing lifespan: A worldwide phenomenon

Important changes in the demographic structure of the world's population are occurring. Increases in life expectancy, most pronounced in the industrialized nations, are being experienced in most parts of the world. Iceland, where a newborn female had a life expectancy of 79.2 years and a newborn male 73 years in 1976, have experienced the greatest increase (U.N. Statistical Yearbook, 1977). Citizens of seven other countries had life expectancies equal to or greater than those prevailing that year in the U.S.A., where females could expect to live 76.5. years and males 68.7 years. All of these countries were characterized by a high level of affluence.

However, increases in life expectancy have occurred in a number of the developing countries, while in some, 30 to 40 years is still the average. (For instance, Upper Volta males had a life expectancy of 32.1 years, females 31.1 years in 1975 and in Bangladesh both sexes had life expectancies at birth of 35.8 years in 1976.) Rapid increases in life expectancy have occurred in a number of Latin American countries since World War II. In Colombia, in 1976 male life expectancy was 59.2 and female 62.7 years and in Mexico, 62.76 and 66.57, respectively. Perhaps the most impressive change has taken place in Japan where the 1976 life expectancies were 72.15 years for males and 77.35 for females. These life expectancies are associated with one of the world's lowest crude death rates, 6.3 per thousand. In comparison, crude death rates of 8.9 in the U.S.A., 7.2 in Canada and 10.5 in France are surprisingly high. Perhaps less surprising but nonetheless noteworthy are crude death rates of 28.1 in Bangladesh, 25.8 in Upper Volta and 22.7 in Nigeria.

From these figures, it would appear that industrialization with its associated benefits of improved nutrition, public health facilities and life-long medical care has been instrumental in creating an environment capable of maximizing the human life span. There are claims of greater life expectancy occurring in certain small, remote populations in South America and the Soviet Union, but in the absence of reliable records, these claims remain unsubstantiated (Mazess and Forman 1979). It should also be emphasized that despite widespread increases in life expectancy at birth there has been relatively little change in longevity, even in the most affluent populations. Thus, a 65—70 year-old male in the U.S.A. has a life expectancy no longer than would have prevailed in the year 1900 (Hayflick 1974).

The lack of significant increase in longevity reflects the fact that increased life expectancies are the product of reductions in the number of "untimely" deaths. A major cause of untimely deaths in human populations has for some time been infectious disease. Reduction in mortalities attributable to tuberculosis, smallpox, scarlet fever and a variety of other diseases of early onset has meant that more people survive into and through middle age. We can only speculate on the likelihood that an individual surviving to age 50 by virtue of medical control of an infectious disease will live to an advanced age. We do not know, for instance, if innate characteristics that enhance survival of a young individual exposed to infectious disease, have similar properties later in life. The pattern is obscured in part because the chief causes of morbidity in the later years have been the so-called degenerative conditions. Much remains to be learned about the role of the immune system in the later years of life (Makinodan 1976, 1978, 1979) but it is entirely possible the segment of today's population reaching age 50 is of a different genetic composition than the one reaching age 50 in the year 1900. Thus, we are still unable to assess the true dimensions of human longevity.

While unable to determine the true potential of the human life span, we are nonetheless confronted with consistent evidence that the female potential is greater than that of the male. The disparity appears greatest in the countries where the life expectancies are greatest, although there is no clear correlation between the two variables. For instance, the most recent figures show life expectancy for females an average of 6.4 years greater than that of males in the nine countries where life expectancies are greatest. In at least 10 countries, male life expectancies are equal to or greater than female. These are all countries where life expectancies are still short (Liberia, Nigeria, Upper Volta, Bangladesh, Kampuchea, India, Indonesia, Jordon, Sabah Malaysia, Pakistan). Table 1 gives a breakdown of these figures and Table 2 provides similar comparisons for the most affluent populations. The greater risk of childbearing in the developing countries certainly influences these figures, as may be seen by inspection of the "birth rate" and "fertility" columns of Tables 1 and 2. But it is unlikely that the stress of childbearing is the sole reason for relative similarity of male and female life expectancies in most developing countries. Other factors are undoubtedly at work in the traditional societies where women are frequently discriminated against in many ways.

Table 1

Life expectancies at birth, birth rates, fertility, death rates and infant mortalities in nations where male life expectancy equals or exceeds female life expectancy at birth

Nation	Life expectancy		Births/1000	Fertility	Death/1000	Infant mortality/1000
	Male	Female				
Upper Volta	32.10	31.10	48.5	197.0	25.8	182.0
Bangladesh	35.80	35.80	49.5	231.7	28.0	?
Nigeria	37.20	36.70	49.3	217.8	22.7	?
India	41.89	40.55	34.5	136.7	14.4	122.0
Kampuchea	44.20	43.30	46.7	143.1	19.0	127.0
Liberia	45.80	44.00	49.8	161.2	20.9	159.2
Sabah Malaysia	48.79	45.43	35.0	179.4	14.4	31.6
Indonesia	47.50	47.50	42.9	175.7	16.9	125.0
Pakistan	53.72	48.80	36.0	174.8	12.0	124.0
Jordan	52.60	52.00	47.6	206.6	14.7	36.3

Source: *Statistical Yearbook: 1977*. New York, United Nations Department of Economic and Social Affairs. 1978

Table 2

Life expectancies at birth, birth rates, fertility, death rates and infant mortalities in industrial nations of high life expectancy

Nation	Life expectancy		Births/1000	Fertility	Death/1000	Infant mortality/1000
	Male	Female				
Canada	69.34	76.36	15.8	61.6	7.2	15.0
U.S.A.	68.70	76.50	14.7	58.5	8.9	15.1
Denmark	71.10	76.80	12.9	61.3	10.7	10.3
France	69.00	76.90	13.6	72.0	10.5	10.4
Netherlands	71.20	77.20	12.9	53.9	8.3	10.5
Japan	72.15	77.35	16.4	62.6	6.3	9.3
Sweden	72.07	77.65	11.9	56.4	11.0	8.7
Norway	71.50	77.83	13.3	64.1	9.9	11.1
Iceland	73.00	79.20	19.4	81.9	6.9	11.7

Source: *Statistical Yearbook; 1977*. New York, United Nations Department of Economic and Social Affairs. 1978

Relationships of growth performance, environment and longevity

Larger body size

Increases in life expectancy have been paralleled by increases in body size. The most pronounced changes have again occurred in the industrialized countries. The most recent statistics (EVELETH and TANNER 1976) indicate that in the U.S.A. the trend toward increased body size has peaked, with mean statures remaining unchanged for the past two decades. A similar pattern appears to be emerging in the other industrialized countries including Japan. Interestingly, the "secular trend" toward increased body size occurred over a much shorter period in Japan, being largely a post World War II phenomenon there. If it has indeed peaked, it would have taken only 35 years as compared to the approximately 100 years estimated for the U.S.A. and Western Europe.

Perhaps more significant than changes in stature are the observed increases in body weight associated with the secular trend. Table 3 shows some of the changes which have occurred between 1883 and 1971 in Sweden (Bengt—Olov et al. 1974). While there is undoubtedly an increase in adipose fat included

Table 3

The secular trend for body weight in Sweden 1883—1971

Age Center (Yr.)	1883 Mean (kg)		1938—39 Mean (kg)		1965—71 Mean (kg)	
	Male	Female	Male	Female	Male	Female
7.0	21.7	21.2	23.5	23.0		
8.0	24.5	23.3	25.9	25.1		
9.0	27.5	26.0	28.3	28.2		
10.0	29.8	28.2	31.5	31.2	32.3	32.0
11.0	31.3	30.7	34.7	34.8	35.3	35.9
12.0	33.4	33.1	38.3	39.3	39.1	40.9
13.0	36.1	37.8	42.7	44.3	43.6	46.0
14.0	40.0	42.2	48.2	49.2	49.5	49.7
15.0	44.6	46.9	54.2	53.5	55.6	52.5
16.0	49.6	50.3	60.0	56.0	60.4	54.4
17.0	55.0	53.1	63.9	57.6	65.4	
18.0	59.5	55.5	66.2	58.5		

Adapted from Bengt-Olov, L.; A. Bergsten-Brucefors and G. Lindgren (1974) "The Secular Trend in Physical Growth in Sweden." *Annals of Human Biology 1*; 245—256.

in these weight increases, much is attributable to lean body mass. The fact is that much of the increase in young adult body weight observed in the industrialized nations is in the form of skeletal muscle. Thus, substantial increases in the amount of metabolically active tissue have occurred. The increase in the net metabolic activity prevailing on a sustained basis is considerable, especially when calculated over the course of a lifetime. Comparison of a 70 kg male with a 60 kg male over a day's activities (Table 4) shows that the heavier male would require nearly 500 kcal. (2092 kilojoules) more per day. These figures are, of course, only approximations and are based on an average for young adults. Changing body composition with increasing age will reduce total energy demand, with the rate of decrement in the basal rate being nearly linear after age 20 (Forbes 1976).

Table 4

Comparison of caloric requirements of a 70 kg U.S. male with those of a 60 kg Colombian male at similar activity levels

	U.S.A.	Colombia
Mean body weight (kg)	70	60
Caloric costs (kcal)		
Resting (8 hours)	570	480
Very light activity (6 hours)	630	540
Light labor (8 hours)	1624	1392
Moderate labor (2 hours)	602	516
Total	3426	2918

Sex differences in body composition

Adult female body composition differs from male sufficiently so that basal metabolic rates are significantly different (Table 5). Body size and body composition are implicated in the lower caloric requirements of females. Sexual dimorphism in human populations reflects these differences in varying ways. For instance, male statures average as much as 110% of female in some populations and as little as 104% in others (STINI 1972a). It is noteworthy that

Table 5

Relationship of adipose tissue to body weight in adult humans (from MASORO 1975)

Age (years)	Ratio adipose tissue mass: body mass	
	Male	Female
25	0.14	0.26
40	0.22	0.32
55	0.25	0.38

greater differences between the sexes occur among the more affluent populations. Even within populations, the more affluent segments exhibit greater sexual dimorphism for stature, as seen in Jamaica (ASHCROFT, HINEAGE and LOVELL 1966) and Ethiopia (DELLAPORTAS 1969). Some caution must be exer cised in interpreting these findings, however, since measurements of young-adults frequently involve females who have all completed growth while many of the males are still growing. Even under optimal circumstances, females are about 10% ahead of males in growth and maturation. When conditions are stressful, the disparity is generally greater. For a variety of reasons, female growth is more canalized than male. The significance of this becomes quite apparent when well nourished and undernourished populations are compared with reference to specific sexually dimorphic characteristics.

For instance, radiographic determinations of skeletal maturity reveal more delay in the appearances of ossification centers and the closure of epiphyses of the hand and wrist of undernourished male children and adolescents than in the case for age-matched females in the same populations (STINI 1969). Lean tissue as estimated from measurement of arm circumference and skinfolds exhibits a similar pattern of male lability in growth when compared to the relative stability of the female (STINI 1972b). Table 6 shows values for arm muscle circumference in adults in a poorly nourished South American population compared to average values for males in the U.S.A. Note the reduction in sexual dimorphism in the Colombian population, females averging 81% of male values for muscle circumference. In U.S. populations female values are only about 66% of female. Muscle circumference of Colombian males is about 66% of that in U.S. males while Colombian females have about 81% the muscle circumference of U.S. females (STINI 1975).

Evolutionary hypotheses seeking an explanation for the apparent stability of female growth compared to that of males in our species have been presented elsewhere (STINI 1971, 1975, 1977a, 1977b, 1978a, 1978b). Here the emphasis will be primarily on the relationship between early growth patterns and longevity.

Table 6

Mean upper arm muscle area of adults of both sexes: U.S.A. and Colombian values (from Stini 1975)

	Colombia		U.S.A.		Colombia % of U.S.A.	
	Arm muscle area (mm²)	Body wt. kg	Arm muscle area (mm²)	Body wt. kg	Muscle area	Body weight
Male	4267	60	6464	70	66	85
Female	3450	51	4272	58	81	88
Female % of male	81	85	66	83		

Human longevity: Actual and potential

The true dimensions of human longevity remain unknown. Nonetheless there has been considerable progress toward a point where extrinsic factors such as disease, trauma and starvation no longer act as the major causes of mortality. From this point on, the intrinsic factors serving to limit the life span will increasingly act as the determinants of longevity. Where cancer and cardiovascular disease are now the predominant causes of mortality, the intrinsic limits of the human life span may already be discernible. It is possible that the evolutionary process has endowed the species with a genetically determined limit to the length of life (Krooth 1974, Cutler 1975, 1979, Denckla 1975, Kanungo 1975, Manning 1976, Sacher 1978). If so, it could be that the life span in contemporary affluent populations is at, or close to, the species limit, and that any future increases in human longevity could be achieved only through manipulation of intrinsic factors.

But it is also possible, that even in the most affluent, longest-lived populations presently living, the environment is not optimal. It is, for instance, possible that at the same time the control of infectious disease has allowed more individuals to live long enough to be susceptible to degenerative diseases, there is also a trend toward greater susceptibility to degenerative diseases. The information needed to identify such a trend is not easily obtained. This is because individuals susceptible to early mortality to infectious disease would not necessarily be the same individuals susceptible to degenerative disease. Too many factors remain unknown to permit useful speculation about the relative effectiveness of the immune response at various stages of the life cycle in past populations. The search for clues to the true dimensions of human longevity must rely primarly on data from living populations. Even in these populations, it is impossible to estimate how many individuals dying of malaria, cholera or influenza might have lived to great age if they had been spared.

Despite the need for caution in interpreting the information we have, it is possible that factors reducing life expectancy in older individuals can be identified and, in some case, ameliorated. Improved understanding of the etiologies of cancer and of cardiovascular disease has permitted treatment and some prologation of life. Average life expectancy in the U.S.A. might be increased by as much as 10—15 years if cardiovascular disease and cancer were eliminated (Siegel 1975).

What can be learned from animal experiments?

Over the past 60 years, various animal experiments have shown that certain kinds of dietary restrictions can have the effect of increasing life expectancy. Beginning with the work of OSBORNE et al. (1917), followed by that of McKAY, CROWELL and MAYNARD (1935), and continuing through the 40's and 50's with the work of TANNENBAUM (1945, 1959), evidence of beneficial effects of a growth-restricting diet has accumulated. Other investigators have continued this work, producing a considerable body of evidence supporting the argument that dietary restriction and reduced growth are associated with lower incidence of tumors and greater life expectancies in a number of species (KRAYBILL 1963, ROSS and BRAS 1971, PAYNE 1972, WALFORD, LIU and GERBASE-DELIMA 1973, JOSE and GOOD 1973, JOSE, STUTMAN and GOOD 1973, DRORI and FOLMAN 1976, CASTER 1976, HAZZARD 1976, ROSS 1976). Recent reviews have summarized aspects of the findings of these studies from several perspectives (LEAF 1973, NATIONAL DAIRY COUNCIL 1975, HAYFLICK 1975, WATKINS 1976, WINICK 1976, STOLTZNER 1977, BARROWS and KOKKONEN 1978, HOUCK 1979) reflecting continued interest in the topic.

GOODRICK (1973, 1977a, 1977b, 1978) has worked with normal and mutant strains of mice under dietary regimes involving restriction of protein and energy intakes. Of particular interest here is his conclusion (1978) that: "The duration and rate of body weight increment . . . appear to be more important predictors of longevity than mean body weight or food intake". Phrased another way, the longer the animal grows before attainment of maximum size, the longer it will live. Stated in yet another way, growth rate and longevity are negatively correlated. Table 7 (taken from GOODRICK 1977a) shows some of the results underlying this conclusion. In addition to the conclusion of GOODRICK, it might also be pointed out that the loss of body weight occurring between the attainment of peak weight and weight during the last month of life was most pronounced in the fastest growing, shortest-lived subjects.

Slowing of the rate of growth early in life will, if sufficiently prolonged, prevent the attainment of the full genetic potential for body size. The reduction in body size under most circumstances is allometric. Thus, it may be quite pronounced without impairment of functional capacity (PAŘÍZKOVÁ and

Table 7

Mean and standard error of the mean for measures of longevity, peak body weight, body weight at last month of life span and month of peak body weight (growth duration) for mutant and control mice (from GOODRICK 1977a)

Strain	L(Months)	BW-P (g)	BW-LM (g)	GD (Months)
Beige (bg)	23.4±1.08	30.4±0.18	27.6±0.47	17.4±1.09
Albino (c^3)	24.4±1.52	32.5±0.31	32.0±0.40	22.3±1.67
Control (C57B1/6J)	27.9±0.93	35.3±0.42	30.6±0.34	21.3±1.60
Yellow (A)	22.2±0.84	53.7±1.61	35.5±5.01	16.3±0.47
Obese (ob)	13.0±1.89	55.2±5.76	27.3±6.56	7.6±0.62

Abbreviations: L = Life Span
BW-P = Peak Body Weight
BW-LM = Body Weight at Last Month of Life Span
GD = Growth Duration

Merhautova 1970). When it occurs, the effect is a reduction of both protein and energy requirements, especially the latter (Nichols et al. 1972). Moreover, the organism generally adjusts its appetite to the level of its needs (Widdowson and McCance 1975). The result may be lifelong reduction in nutrient requirements. If a lower level of total energy consumption summed over a lifetime influences tissue changes associated with aging, one of the beneficial effects of restricted diets on longevity may be so derived. Other factors which might be implicated are the reduction of the rate of tumor growth under conditions of low protein intake (Shils 1975) and, possibly in other cases, tumor inhibition associated with adrenal hyperfunction (Alcantara and Speckmann 1976). A variety of changes in immune function can arise from dietary modifications (Good 1977, Tyan 1979) so that the permutations and combinations possible in the interaction of diet, growth and disease are many. But it does appear quite possible for an organism to attain a body size considerably smaller than its genetic potential, remain viable and achieve a greater life span than its larger conspecifics under laboratory conditions. Whether this is the case in wild populations has not been shown. But, in most of the species used as experimental animals, individuals from wild populations are, on the average, smaller than domesticated strains. Without more information concerning ongevity in the wild state, little more can be said.

Aging and body composition

In humans, as in laboratory animals, the process of aging is one in which cell number decreases and metabolic rate, therefore, declines (Forbes 1974, 1976, Malina 1969, Tzankoff and Norris 1978). This does not mean that the rate of energy conversion in the individual cells has slowed. Rather, the reduction in the number of actively metabolising cells leads to a net reduction in the total number of reactions requiring energy. The maintenance requirements of most tissues, dependent upon a supply of amino acids, do not decrease as rapidly as do total energy requirements (Munro and Young 1978, Masoro et al. 1979). Thus, an across-the-board reduction in food intake to a level appropriate to the individual's reduced energy requirements may lead to inadequate protein intake (Young and Gersovitz 1978). Only recently have some of the phenomena associated with the decline of human body size with age begun to be understood. Muscle makes a smaller contribution to total body protein metabolism in older people than in younger ones (Uany et al. 1978, Young 1968, Young et al. 1963, Young and Gersovitz 1978, Young and Munro 1978). Usually body composition is altered favoring the acquisition of fat (Roberts, Andrews and Caird 1975, Masoro 1977). Thus, even when weight stays the same, metabolic rate, strength and speed of reaction all decline (Clement 1974, Lamphear and Montoye 1976, Malina 1975, Masoro 1975). Both males and females are subject to these changes (Novak 1972) but females begin the aging process with a higher proportion of fat and a lower basal metabolic rate than males and their fate of decline is thus not as pronounced (Burmeister 1965, Flynn et al. 1970, Novak 1973, Noppa et al. 1979).

The role of exercise in age-associated changes in body composition is of considerable significance, as has been shown by studies of hospitalized individuals (MacLennan, Martin and Mason 1975) and by longitudinal studies of individuals following their normal routine of activity (Robinson et al. 1975). The beneficial effects of exercise programs, even when instituted in the later years of life, indicate that some of the changes seen in the underexercised and overfed populations of industrialized nations are not entirely irreversible (SUOMINEN, HEIKKINEN and PARKATTI 1977, PAŘÍZKOVÁ 1977, PAŘÍZKOVÁ and EISELT 1971, PAŘÍZKOVÁ et al. 1971). Exercise, improved aerobic capacity and the general improvement in condition they induce give evidence that one important facet of aging is a trend toward chronic hypoxemia (CHEBTAREV, KORKUSHKO and IVANOV 1974). Certainly, performance of exceptional athletes 60 years old (POLLACK, MILLER and WILMORE 1974a) and even up to age 75 (POLLACK, MILLER and WILMORE 1974b) give evidence that the decline in physical performance need not resemble the pattern predominant in the industrialized nations (CANTWELL and WATT 1974).

Early growth, aging and death

It was pointed out earlier that life expectancy at birth has increased the most in areas where the secular increase in body size has been most pronounced (VAN WIERINGEN 1978). Moreover, these are the same areas in which menarcheal age has also been reduced to what now appears to be its minimum (TANNER 1975). Also, the populations involved are those in which sexual dimorphism for body size is most pronounced and where the difference in male and female life expectancy is greatest.

A number of factors are implicated in the pattern of growth prevalent in contemporary industrialized societies. Improved medical care and diets abundant in both protein and energy sources are essential elements. It is uncertain, however, whether the increase in body size, dimorphism and life expectancy can all be attributed to the same dietary constituents. The uncertainty is heightened by a lack of populations where Western medical care has been adopted while non-Western dietary habits have been retained. Lacking evidence to the contrary, it could be argued that dietary practices that maximize growth may also limit life expectancy (KAGAWA 1978, DOCK and FUKUSHIMA 1979).

Male growth is more affected than female by environmental factors.There is a greater increase of male body size than female arising from nutritional abundance. This raises the question of whether enhancement and acceleration of male growth are implicated in the widening disparity between male and female life expectancies. Obesity has generally (if not always accurately) been conceded to have a role in predisposing the individual to heart disease and cancer. But where fat is increasing, it is often the case that lean body mass is increasing simultaneously (FORBES 1964). Early nutritional intake appears to have long-term effects on body composition (SVEGER et al. 1975, CHARNEY et al., 1976, MELBIN and VUILLE 1976). It may endow the organism with a metabolic demand that is not only costly to satisfy but also potentially detrimental to the attainment of maximum longevity.

It has long been believed that skeletal muscle, like nervous tissue, attained the adult complement of cells at or before birth (OLIVIER 1869, HAYERN 1875, BOMPAR 1887, MACCALLUM 1898, DURANTE 1902, BRAMWELL and MUIR 1907, BABLET and NORMET 1937). However, data from other studies indicate a capacity for the addition of skeletal muscle cells early in postnatal life (CHEEK 1968, CHEEK, BRASEL and GRAYSTONE 1968, MONTGOMERY 1962a), and even as late as the fifth decade of life (ADAMS and DERUECK 1973). Work with autopsy material from severely malnourished individuals (MONTGOMERY 1962b) gives evidence of loss of fibers already present at birth rather than a reduction in the number of new fibers appearing in the postpartum period. The result is a smaller complement of muscle fibers, each of which appears to be of normal size. Experimental work with pigs switched to low protein diets immediately after weaning (STINI 1972c) has yielded evidence that in that species, the mechanism is most likely one of fiber loss. Other work with rats (SIDRANSKY and VERNEY 1970) supports that conclusion.

Although it is not known whether mild undernutrition induces muscle fiber loss, there is substantial evidence that nutritional abundance stimulates lean body mass growth through hypertrophy, hyperplasia, or possibly both. Work with experimental animals has shown that forced excess of nitrogen in the diet of young animals will lead to retention of up to 90% of the excess (ADOLPH 1972). WINICK, BRASEL and ROSSO (1972), attributed this retension to non-hyperplastic factors. LOWRY (1973) has found similar retention levels in human infants.

CHAVEZ and his colleagues, working in a poor rural population in Mexico, recorded greater efficiency of protein intake in male children during breast-feeding (CHAVEZ et al. 1973). In their study, male infants consumed essentially the same amount of breast milk during their first year of life but gained more weight (5.13 kg in males on the average and 4.28 kg in females). CHAVEZ calculated a weight increase of 4.9 grams per gram of protein ingested by male infants and 3.7 grams per gram for females. From these data, CHAVEZ concluded that males are more efficient synthesizers of carcass protein in circumstances of low protein intake. Similar sex differences have been recorded in baboons (a species of pronounced sexual dimorphism for body size), where male efficiency of weight gain measured 4.7 grams per gram of protein and female 3.7 grams per gram. In adolescence, the human male grows much more vigorously than the female (TANNER 1975, ZORAB 1969) although the female may possess slightly more muscle in the lower limb at ages 10 or 11 years (MARESH 1970). Certainly, male increase in strength is disproportionately large after adolescence (CARRON and BAILEY 1974).

Conclusions

It would be premature to claim a direct cause-and-effect relationship between the enhancement of male growth, increased sexual dimorphism for body size and the increased disparity between the life expectancies of males and females in industrialized societies. Nor would it be possible to assert simply that body size increases are detrimental to human longevity. But, the fact remains that males have higher mortality rates throughout most of the life cycle (with the exception of ages over 75 years) (MÁDAI 1978, OMACHI 1978). Male mortalities are higher for most kinds of cancer and the prognosis for the male patient is poorer than for the female patient upon the diagnosis of cancer, whatever the stage of the disease or type of treatment (CORREA and HAENSZEL 1975).

The slowdown of increases in body size in the industrialized countries gives evidence that maximum body size is being attained. Along with increases in body size, there has been earlier attainment of adult size and sexual maturity in both sexes. In GOODRICK's animal experiments, reductions in the time taken to attain adult body size are correlated with reductions in life span. While no correlations of this nature have yet been identified in human populations, it is not possible to rule out the possibility that acceleration of growth, maximization of body size and early attainment of sexual maturity is not an optimal outcome (STINI 1979). The human growth curve is unique in that it contains an adolescent growth spurt following 10 to 15 years of slow but steady growth. Human longevity is relatively great compared to that of other mammals and, in general, late maturity and greater longevity are correlated in mammalian species. It does appear that humans live longer than would be predicted on the basis of total caloric activity per kilogram of body weight calculated over a lifetime (CUTLER 1979). Whether the nutritional habits that prevail in modern industrialized nations have the potential of altering that relationship is an open question. The "natural" diet of humans is not known for certain (GAULEN and KONNER 1977). But it is highly unlikely that it resembled the high protein, high fat, high energy, high density one prevalent in much of the world today. It may be that dietary factors responsible for the acceleration of growth are also implicated in the failure of the affluent members of the human species to attain their full longevity.

REFERENCES

ADAMS, R. D.—DE RUECK, J. (1973): Metrics of muscle. — *In: Basic Research in Myology Proceedings of the II International Congress on Muscle Diseases*, Part I, pp. 3—11. Amsterdam. Excerpta Medica ICN Series 294.

ADOLPH, E. F. (1972): Development of Physiological Regulations. — *In:* WINICK, M. (Ed.): *Nutrition and Development*, pp. 1—25. John Wiley and Sons. New York.

ALCANTARA, E. N.—SPECKMANN, E. W. (1976): Diet, nutrition and cancer. — Am. J. Clin. Nutr., *29;* 1035—1047.

ASHCROFT, M. T.—HENEAGE, P.—LOVELL, H. G. (1966): Heights and weights of Jamaican school children of various ethnic groups. — Am. J. Phys. Anthrop., *24;* 35—44.

BABLET, J.—NORMET, L. (1937): Les lésions histopathologiques de la bouffissure d'Annam. — Bulletins of the Academy of Medicine, *117;* 242.

BARROWS, C. H. JR.—KOKKONEN, G. C. (1978): Diet and life extension in animal model systems. Age, *1;* 131—143.

BENGT-OLOV, L.—BERGSTEN-BRUCEFORS, A.—LINDGREN, G. (1974): The secular trend in physical growth in Sweden. — Annals of Human Biology, *1;* 245—256.

BOMPAR, F. (1887): Etude sur l'atrophie des muscles thoraciques chez les turberculeux. — Journal of Medicine of Bordeux, *17;* 121—130.

BRAMWELL, F.—MUIR, A. (1907): A remarkable muscular lesion occurring in sprue with notes of a case of peculiar (myopathic) muscular atrophy in which somewhat similar changes were pictured. — Quarterly Journal of Medicine, *1;* 1.

BURMEISTER, W. (1965): Body cell mass as the basis of allometric growth functions. — Annals of Paediatrics, *204;* 65.

CANTWELL, J. D.—WATT, E. D. (1974): Extreme cardiopulmonary fitness in old age: studies on a world record distance runner. — Gerontologica *65;* 357—359.

CARRON, A. V.—BAILEY, D. A. (1974): Strength development in boys from 10 through 16 years. — *Monographs of the Society for Research in Child Development*, 39 (4).

CASTER, W. O. (1976): Role of nutrition in human aging. — *In:* ROCKSTEIN, M. and SUSSMAN, M. (Eds): *Nutrition, Longevity and Aging*. Academic Press, New York.

CHARNEY, E.—GOODMAN, H. C.—MCBRIDE, M.—LYON, B.—PRATT, R. (1976): Childhood antecedents of adult obesity. — New Engl. J. Med., *295;* 6—9.

CHAVEZ, A.—MARTINEZ, C.—RAMOS-GALVAN, R.—CORONDADO, M.—BOURGER, H.—DIAZ, D.—BASTA, S.—NIEVES, M.—GARCIDUENAS, O. (1973): Nutrition and development of infants from poor rural areas IV. Differences attributable to sex in the utilization of mother's milk. Nutrition Reports International, *7;* 603—609.

CHEBOTAREV, D. F.—KORKUSHO, O. V.—IVANOV, L. A. (1974): Mechanisms of hypoxemia in the elderly. — Journal of Gerontology, *29;* 393—400.

CHEEK, D. B. (1968): Muscle cell growth in normal children. — *In:* CHEEK, D. B. (Ed.): *Human Growth, Body Composition, Cell Growth, Energy and Intelligence.* — Pp. 337—351. Lea and Febiger, Philadelphia.

CHEEK, D. B.—BRASEL, J.—GRAYSTONE, J. E. (1968): Muscle cell growth in rodents: sex difference and the role of hormones. — *In:* CHEEK, D. B. (Ed.): *Human Growth, Body Composition, Cell Growth, Energy and Intelligence.* Pp. 306—325. Lea and Febiger, Philadelphia.

CLEMENT, F. J. (1974): Longitudinal and cross-sectional assessments of age changes in physical strength as related to sex, social class and mental ability. — Journal of Gerontology, *29;* 423—429.

CORREA, P.—HAENSZEL, W. (1975): Comparative international incidence and mortality. — *In:* SCHOTTENFELD, D. (Ed.): *Cancer Epidemiology and Prevention.* — Charles C. Thomas. Springfield, Illinois.

CUTLER, R. G. (1975): Evolution of human longevity and the genetic complexity governing aging rate. — Proceedings of the National Academy of Science, U.S.A., *72;* 4664—4668.

— (1979): Evolution of human longevity: a critical overview. — Mechan. Aging and Develop., *9;* 337—354.

DEHN, M. M., and BRUCE, R. A. (1972): "Longitudinal variations in maximal oxygen intake with age and activity." J. Appl. Physiol. *33;* 305—307.

DELLAPORTAS, G. J. (1969): Growth of school children in Gondararea, Ethiopia. — *Human Biology, 41;* 218—222.

DENCKLA, W. D. (1975): A time to die. — Life Science, *16;* 31—44.

DOCK, D. S.—FUKUSHIMA, K. (1978): A longitudinal study of blood pressure in the Japanese, 1958—1972. — J. Chronic Dis., *31;* 669—689.

DRORI, D.—FOLMAN, Y. (1976): Environmental effects on longevity in the male rat: exercise, mating, castration and restricted feeding. — Experimental Gerontology, *11;* 25—32.

DURANTE, G. (1902): Anatomie pathologique des muscles. *In* CORNEL, A. V.—RANVIER, L. A. (Eds): *Manuel d'histologie pathologique.* Alcan, Paris.

EVELETH, P.—TANNER, J. M. (1976): *Worldwide Variation in Human Growth.* — Cambridge University Press, Cambridge—London—New York—Melbourne.

FLYNN, M. A.—MURTHY, Y.—CLARK, J.—COMFORT, G.—CHASE, G.—BEUTLEY, A. E. T. (1970): Body composition of negro and white children. — Archives of Environmental Health, *20;* 604.

FORBES, G. (1964): Lean body mass and fat in obese children. — Pediatrics, *34;* 308—314.

— (1974): Stature and lean body mass. — Am. J. Clin. Nutr. *27;* 595.

— (1976): The adult decline in lean body mass. — Human Biology, *48;* 161—173.

GAULIN, S. J. C.—KONNER, M. (1977): On the natural diet of primates, including humans. *Nutrition and the Brain,* Vol. I. Raven, New York.

GOOD, R. A. (1977): "Biology of the cell-mediated immune response — a review." — *In:* SUSKIND, R. M. (Ed.): *Malnutrition and the Immune Response.* Raven Press, New York.

GOODRICK, C. (1973): The effects of dietary protein upon growth of inbred and hybrid mice. — Growth, *37;* 355.

— (1977a): Body weight change over the life span and longevity for C57BL/6J mice and mutations which differ in maximal body weight. — Gerontology, *23;* 405.

— (1977b): Body weight increment and length of life II. The effect of genetic constitution and dietary proteins. — Journal of Gerontology.

— (1978): Behavior genetics and aging. *In:* SCHNEIDER, E. L. (Ed.): *The Genetics of Aging.* pp. 403—415. Plenum, New York.

HAYERN, M. G. (1875): Note sur maladies musculaires qu'on observe dans les maladies chroniques. Comptes Rendus Sociologiques et Biologiques, *1;* 69.

HAYFLICK, L. (1974): Cytogerontology. — *In:* ROCKSTEIN, M. (Ed.): *Theoretical Aspects of Aging.* Academic Press, New York.

— (1975): Current theories of biological aging. — Federation Proceedings, *34;* 9—13.

HAZZARD, W. R. (1976): Aging and atherosclerosis: interaction with diet, heredity and associated risk factors. — *In:* ROCKSTEIN, M.—SUSSMAN, M. (Eds): *Nutrition, Longevity and Aging.* Pp. 143—197. Academic Press, New York.

HOUCK, J. C. (1979): The relevance of growth control (chalones) to the aging process. — Mechan. Aging and Develop., *9;* 463—470.

JOSE, D. G.—GOOD, R. A. (1973): Quantitative effects of nutritional protein and caloric deficiency upon immune responses to tumors in mice. — Cancer Research, *33;* 807—812.

JOSE, D. G.—STUTMAN, O.—GOOD, R. A. (1973): Good, long-term effects on immune function of early nutritional deprivation. — Nature, *241;* 57—58.

KAGAWA, Y. (1978): Impact of Westernization on the nutrition of Japanese: changes in physique cancer longevity and centenarians. — *Prevent, Med., N. Y., 7;* 205—217.
KANUNGO, M. S. (1975): A model for aging. — Journal of Theoretical Biology, *52;* 253—262.
KRAYBILL, H. F. (1963): Carcinogenesis associated with foods, food additives, food degradation products and related dietary factors. — Clin. Pharmacol. Theropeutics, *4;* 73—87.
KROOTH, R. S. (1974): A deterministic mechanism for cellular and organismic aging. Journal of Theoretical Biology, *46;* 501—507.
LAMPHIEAR, D. E.—MONTOYE, H. J. (1976): Muscular strength and body size. — Human Biology, *48;* 147.
LEAF, A. (1973): Getting old. — Scientific American, *229;* 45—52.
LOWRY, G. H. (1973): *Growth and Development of Children* (6th ed. pp. 335—337). — Year Book Medical Publishers, Chicago.
MACCALLUM, J. B. (1898): On the histogenesis of the striated muscle fiber, and the growth of the human sartorius muscle. — Johns Hopkins Hospital Bulletin, *90—91;* 208—215.
MACLENNAN, W. J.—MARTIN, P.—MASON, B. J. (1975): Energy intake disability, disease and skinfold thickness in a long-stay hospital. — Gerontology Clinic, *17;* 173—180.
MÁDAI, L. (1978): Excess male mortality trends in the young production ages in Europe since the beginning of the twentieth century. — Demografia, Budapest, *20;* 299—313.
MAKINODAN, T. (1976): Immunobiology of aging. — Journal of the American Geriatrics Society, *24;* 249—252.
— (1978): Mechanism, prevention and restoration of immunologic aging. — Birth Defects, *14;* 197—212.
— (1979): Control of immunologic abnormalities associated with aging. — Mechan. Ageing and Develop., *9;* 7—17.
MALINA, R. M. (1969): Quantification of fat, muscle and bone in man. — Clin. Orthrop. Rel. Res., *65;* 9.
— (1975): Anthropometric correlates of strength and motor performance. — Exercise Sport Sci. Rev., *3;* 249.
MANNING, J. T. (1976): Life cycle patterns and their genetic control: an attempt to reconcile evolutionary and mechanistic speculation. — Acta Biotheor., *25;* 111—129.
MARESH, M. M. (1970): Measurements from roentgenograms, heart size, long bone lengths, bone muscle and fat widths, skeletal maturation. — *In:* MCCAMMAN, R. W. (Ed.): *Human Growth and Development*, pp. 155—200. Charles C. Thomas, Springfield, Illinois.
MASORO, E. J. (1975): Other physiologic changes with age. — *In:* ASTFELD, A. M. (Ed.): *Epidemiology of Aging.* — Bethesea, DHEW Publication NIH77—711.
— (1977): Lipids and lipid metabolism. — Ann. Rev. Physiol., *39;* 301—321.
MASORO, E. J.—BERTRAND, H.—LIEPA, G.—YU, B. P. (1979): Analysis and exploration of age-related changes in mammalian structure and function. — Federation Proc., *38;* 1956—1961.
MAZESS, R. B.—FORMAN, S. H. (1979): Longevity and age exaggeration in Vilcabamba, Ecuador. — Journal of Gerontology, *34;* 94—98.
MCCAY, C. M.—CROWEL, M. F.—MAYNARD, L. A. (1935): The effect of retarded growth upon the length of life span and upon the ultimate body size. — Journal of Nutrition, *10;* 63—79.
MELBEIN, T.—VUILLE, J. C. (1976): Relationship of weight gain in infancy to subcutaneous fat and relative weight at 10½ years of age. — Brit. J. Prev. and Soc. Med., *30;* 239—243.
MONTGOMERY, R. D. (1962a): Growth of human striated muscle. — Nature, *195;* 194.
— (1962b): Muscle morphology in infantile protein malnutrition. — J. Clin. Path. *15;* 511—521.
MUNRO, H. N.—YOUNG, V. R. (1978): Protein metabolism in the elderly: observations relating to dietary needs. — Postgrad Med., *63;* 143—148.
NATIONAL DAIRY COUNCIL (1975): *Nutrition, diet and cancer.* — Dairy Council Digest, *46;* 25—30.
NICHOLS, B. L.—ALVARADO, J.—HAZELWOOD, C. F.—VITERI, F. (1972): Clinical significance of muscle potassium depletion in protein-calorie malnutrition. — Journal of Pediatrics, *80;* 319.
NOPPA, H.—ANDERSON, M.—BENGTSSON, C.—BRUCE, A.—ISAKSSON, B. (1979): Body composition in middle-aged women with special reference to the correlation between body fat mass and anthropometric data. — Am. J. Clin. Nutr., *32;* 1388—1395.
NOVAK, L. (1972): Aging, total body potassium, fat-free mass, and cell mass in males and females between ages 18 and 85 years. — J. Gerontol., *27;* 438—433.
OLIVIER, A. (1869): Des atrophies musculaires. — Unpublished thesis, Paris.

OMACHI, C. (1978): Needs and problems of aging women in comparison with aging men. — Jap. J. Geriat., *15;* 307—315.

OSBORNE, T. B.—MENDEL, L. B.—FERRY, E. L. (1917): The effect of retardation of growth upon breeding period and duration of life of rats. — Science, *5;* 294—295.

PAŘÍZKOVÁ, J. (1977): *Body Fat and Physical Fitness. Body Composition and Lipid Metabolism in Different Regimes of Physical Activity.* Martinus Nyhoff B.V./Med. Div. The Hague.

PAŘÍZKOVÁ, J.—EISELT, E. (1971): A further study on changes in somatic characteristics and body composition of old men followed longitudinally for 8—10 years. — Human Biol., *43;* 318—326.

PAŘÍZKOVÁ, J.—EISELT, E.—SPRYNAROVA, S.—WACHTLOVA, M. (1971): Body composition, aerobic capacity and density of muscle capillaries in young and old men. — J. Appl. Physiol., *31;* 323—325.

PAŘÍZKOVÁ, J.—MERHAUTOVA, J. (1970): The comparison of somatic development, body composition and functional characteristics in Tunisian and Czech boys of 11 and 12 years. — Human Biology, *42;* 391—400.

PAYNE, P. R. (1972): Influence of energy intake on aging and longevity. — *Proceedings on the 9th International Congress of Nutrition.* Mexico, 1972.

POLLACK, M. L.—MILLER, H. S. JR.—WILMORE, J. (1974a): Physiological characteristics of champion American track athletes 40 to 75 years of age. — Journal of Gerontology, *29;* 645—649.

— — — (1974b): A profile of a champion distance runner, age 60. — Medical Science and Sports, *6;* 118—121.

ROBERTS, M. A.—ANDREWS, G. R.—CAIRD, R. I. (1975): Skinfold thickness of the dors of the hand in the elderly. — Age and Aging, *4;* 8—15.

ROBINSON, S.—DILL, D. B.—TZANBOFF, S. P.—WAGNER, J. A.—ROBINSON, R. D. (1975): Longitudinal studies of aging in 37 men. — Journal of Applied Physiology, *38;* 263—267.

ROSS, M. H. (1976): Nutrition and longevity in experimental animals. — *In:* WINICK, M. (Ed.): *Nutrition and Aging*, pp. 43—61. John Wiley and Sons, New York.

ROSS, M. H.—BRAS, G. (1971): Lasting influence of early caloric restriction on prevalence of neoplasms in the rat. — Journal of the National Cancer Institute, *47;* 1095—1113.

SACHER, G. A. (1978): Evolution of longevity and survival characteristics of mammals. — *In:* SCHNEIDER, E. L. (Ed.): *The Genetics of Aging*, pp. 151—168. Plenum Press, New York.

SHILS, M. (1975): Nutrition and cancer: dietary deficiency and modifications. — *In:* SCHOTTENFELD, D. (Ed.): *Cancer Epidemiology and Prevention: Current Concepts.* Charles Thomas, Springfield, Illinois.

SHOCK, N. W. (1962): The science of gerontology. — *In:* JEFFERS, E. C. (Ed.): *Proc. Seminars, 1956—61 Durham, N. C.: Council on Gerontology*, pp. 123—140. Duke University Press, Durham, N. C.

SIDRANSKY, H.—VERNEY, E. (1970): Skeletal muscle protein metabolism changes in rats force fed a diet inducing an experimental kwashrorkor-like model. — American Journal of Clinical Nutrition, *23;* 1154—1159.

SIEGEL, J. S. (1975): Some demographic aspects of aging in the United States. — *In:* OSTFELD, A. M.—GIBSON, D. G. (Eds): *Epidemiology of Aging.* — Bethesda USHEW DHEW Publication (NIH) 77—711.

STINI, W. A. (1969): Nutritional stress and growth: sex difference in adaptive response. — Am. J. Phys. Anthrop., *31;* 417—426.

— (1971): Evolutionary implications of changing nutritional patterns in human populations. — American Anthropologist, *73;* 1019—1030.

— (1972a): Malnurition, body size and proportion. — Ecology of Food and Nutrition, *1;* 126—132.

— (1972b): Reduced sexual dimorphism in upper arm muscle circumference associated with protein-deficient diet in a South American population. — Am. J. Phys. Anthrop., *36;* 341—352.

— (1972c): Lean body mass reductions in domestic hogs subjected to protein deficient diet. (Abstract). Am. J. Phys. Anthrop., *37;* 451.

— (1975): Adaptive strategies of human populations under nutritional stress. — *In:* WATTS, E.—JOHNSTON, F. E.—LASKER, G. L. (Eds): *Biosocial Interrelations in Population Adaptation*, pp. 19—41. Mouton. The Hague.

— (1977a): Accelerated growth and its long-range consequences. — *In:* EIBEN, O. G. (Ed.): *Growth and Development: Physique.* Symp. Biol. Hung., *20;* 83—95. Akadémiai Kiadó, Budapest.

— (1977b): Reduced growth and protein deficiency in South American populations. — *Proceedings of the Rocky Mountain Council for Latin American Research.* Lincoln, Nebraska,

RMCLAS.
— (1978a): Human growth as an adaptive strategy. — *Colloquia of the Fort Burgwin Research Center, 2;* 47—62.
— (1978b): Early nutrition, growth, diseases, and human longevity. — Nutrition and Cancer, *1;* 31—39.
— (1979): Errors of a nutritional policy to maximize human growth. — *In:* RAPHAEL, D. (Ed.): *Breastfeeding and Food Policy in a Hungry World*, pp. 177—182. Academic Press, New York.
STOLTZNER, G. (1977): Effects of life-long dietary protein restriction on mortality, growth, organ weights, blood counts, liver aldolase and kidney catalase in Balb/c mice. — Growth, *41;* 337—348.
SUOMINEN, H.—HEIKKINEN, E.—PORBATTI, T. (1977): Effect of eight week's physical training on muscles and connective tissue in the m. vastus lateralis in 69-year-old men and women. — Journal of Gerontology, *32;* 33—37.
SVEGER, T.—LINDBERG, T.—WEIBULL, B.—OLSSON, V. L. (1975): Nutrition, over-nutrition and obesity in the first year of life in Malmo, Sweden. — Acta Paediatr. Scand., *64;* 635—640.
TANNENBAUM, A. (1945): The dependence of tumor formation on the composition of the calorie restricted diet as well as on the degree of restriction. — Cancer Res., *5;* 616—625.
— (1959): Nutrition and cancer. — *In:* HOMBERGER, F. (Ed.): *Physiopathy of Cancer*, 2nd ed., pp. 517—562. Hoeber—Harper, New York.
TANNER, J. M. (1965): Radiographic studies of body composition in children and adults. — *In:* BROŽEK, J. (Ed.): *Human Body Composition: Approaches and Applications. Symposia of the Society for the Study of Human Biology, 7;* 211—236. Pergamon Press, Oxford.
— (1975): Trends toward earlier menarche in London, Oslo, Copenhagen, the Netherlands and Hungary. — Nature, *243;* 95.
TYAN, M. L. (1979): Development of immune competence. — Mechan. Ageing and Develop, *9;* 79—86.
TZANKOFF, S. P.—NORRIS, A. H. (1978): Longitudinal changes in basal metabolism of man. — J. appl. Physiol: respirat. environ. exercise Physiol, *45;* 536—539.
UANY, R.—WINTERER, J. C.—BILMAZES, C.—HAVERBERG, L. N.—SCRIMSHAW, N. S.—MUNRO, H. N.—YOUNG, V. R. (1978): The changing pattern of whole body protein metabolism in aging humans. — Journal of Gerontology, *33;* 663—671.
VAN WIERINGEN, J. E. (1978): Secular growth changes. — *In:* FALKNER, F.—TANNER, J. M. (Eds): *Human Growth 2: Postnatal Growth*, pp. 445—473. Plenum Press, New York.
WALFORD, R. L.—LIN, R. K.—GERBASE-DELIMA, M. (1973): Long-term dietary restriction and immune function in mice: response to sheep red blood cells and to mutagenic agents. — Mechanisms of Aging and Development, *2;* 447—454.
WATKINS, D. M. (1976): Biochemical impact of nutrition on the aging process. — *In:* ROCKSTEIN, M.—SUSSMAN, M. (Eds): *Nutrition Longevity and Aging.*, pp. 47—67. Academic Press, New York.
WIDDOWSON, E. M.—MCCANCE, R. A. (1975): A review: new thoughts on growth. Pediatric Research, *9;* 154—156.
WINICK, M. (1976): *Nutrition and Aging.* John Wiley and Sons, New York.
WINICK, M.—BRASEL, J. A.—ROSSO, R. (1972): Nutrition and cell growth. — *In:* WINICK, M. (Ed.): *Nutrition and Development*, pp. 59—67. John Wiley and Sons, New York.
YOUNG, C. M.—BLONDIN, J.—TENSUAN, R.—FRYER, J. H. (1963): Body composition of "older" women. — J. Am. Diet Assoc., *43;* 344—348.
YOUNG, V. R. (1978): Nutrition and aging. — Adv. exp. Med. Biol., *97;* 85—110.
YOUNG, V. R.—GERSOVITZ, M. (1978): Protein and amino acid metabolism in the aged. — *In:* NANDY, K. (Ed.): *Senile Dementia; A Biomedical Approach*, pp. 287—305. Elsevier, North Holland Biomed Press, New York.
YOUNG, V. R.—MUNRO, H. N. (1978): (3-methylhistidine) and muscle protein turnover: an overview. — Federation Proc., *37;* 2291—2300.
ZORAB, P. A. (1969): Normal creatinine and hydroxyproline excretion in young persons. — LANCET, *2;* 1164.

Author's address: Prof. Dr. WILLIAM A. STINI
Dept. Anthropology, University of Arizona
Tucson, Arizona
U.S.A.

Anthrop. Közl. *24;* 263—267. 1980.

RELATIONSHIPS OF BONE AGE, PHYSICAL DEVELOPMENT AND ATHLETIC PERFORMANCE AT THE AGE OF 11 TO 12 YEARS

by T. SZABÓ and J. MÉSZÁROS

(Central School of Sports, Budapest, Hungary; Department of Medicine, Hungarian University of Physical Education, Budapest, Hungary)

Abstract. Performance in five athletic tests and seven body dimensions were measured, CONRAD's two indices of growth type and wrist bone age were assessed in 26 girls and 16 boys engaged in track and field events. The chronological age of the subjects ranged from 10.9 to 12.9; their bone age showed a mean acceleration of 6 to 8 months (about 7%). The purpose of the study was to see if physique and performance were related to biological age. The girls were less robust and more leptomorphic than the non-athletic reference group, but had a similar stature and minimally lighter weight. The boys were taller, heavier and more robust than their nonathletic age-mates. Bone age was significantly related in both sexes to all body dimensions and the plastic index, to three performance items in the boys and to four in the girls. In order to help estimation of biological age in a simple way, prediction formulae were developed for the two sexes from stature, hand circumference and calendar age. These may help the coach to avoid mistaking accelerated youths for talented ones, and to assign training exercise more adequately.

Key words: biological age and performance, estimation of bone age, track and field athletes.

Introduction

Coaches are always on the hunt for individuals talented in athletic activities. In selecting trainees from among the children who volunteer for long-term training the risk of mistakes is particularly great. This led the coaches to prefer physically well-developed pupils, because these are likely to perform better at an earlier age. It is a common error of the coaches, however, that they tend to consider children with an advanced maturation being more talented than the ones following the normal course of development.

The present study was initiated to see if in motor tests commonly employed in the selection procedure performance was related to biological age, and how physique related to the same.

Material and Methods

Twelve min run-walk, 60 m dash, long and high jump, fistball throw and seven body dimensions were measured in 42 track and field athletes between 10.9 and 12.9 years, 26 girls and 16 boys. Test performance was registered according to athletic principles. In recording body dimensions IBP suggestions

(Weiner and Lourie 1969) were observed. Bone age was estimated by comparing wrist X-rays to a standard atlas (Greulich and Pyle 1959). Body dimensions were used also to calculate Conrad's metric and plastic indices (Conrad 1963) which previously were evidenced to follow a characteristic pattern during development (Szmodis et al. 1976). Where available, a comparison with healthy non-athletic reference groups was also made (Mészáros and Mohácsi 1978). Formulae developed for bone age estimation were derived by multivariate regression equations.

Results and Discussion

Developmental status of the subjects is shown in Fig. 1. The boys were taller than, and the girls agreed with the reference stature. The boys were heavier while the girls were minimally lighter and less robust (plastic index) than their age-mates. The boy's metric index agreed with the reference data. Girl athletes

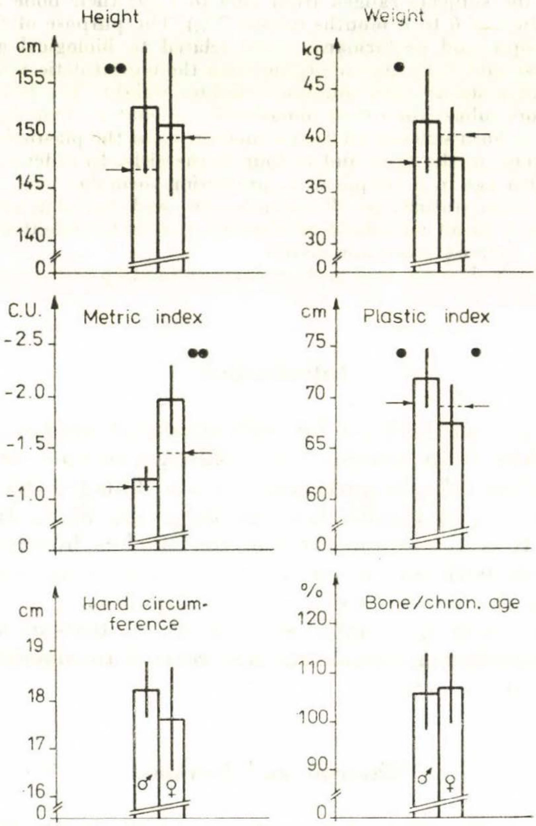


Fig. 1: **Physique of adolescent track and field athletes. The arrows denote non-athletic reference means. Presence and number of bold circles indicate significant differences on the 5% (single circle) or 1% (double circle) level. — Bone/chron age: ratio of bone age to chronological age; C.U.: Conrad units of leptomorphy—pyknomorphy scale**

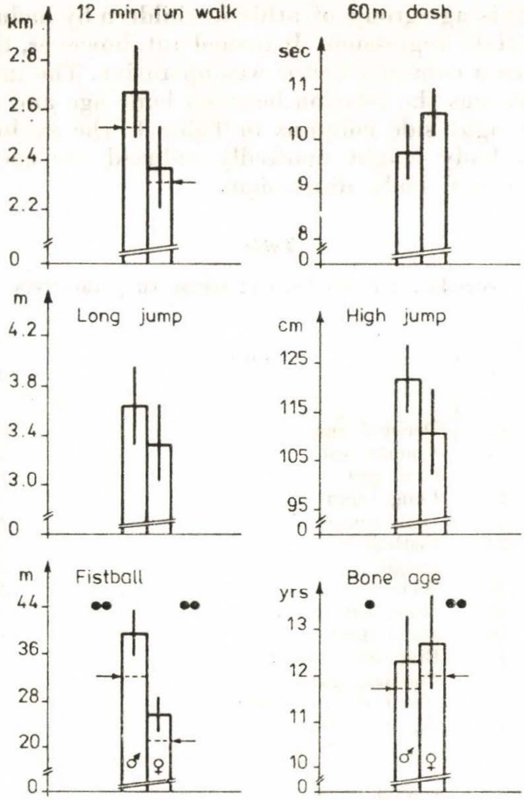


Fig. 2: Performance in adolescent track and field athletes. Except the bars of bone age where they refer to the subjects' own chronological age, the arrows denote non-athletic reference means. Variability is standard deviation

showed marked leptomorphy (metric index), exceeding in linearity not only the boys (as usual before puberty), but also the reference group. Both sexes displayed a mean acceleration of about 7% in bone age.

Performance of the test group (Fig. 2) in the 12-min run-walk though higher, failed to exceed reference values significantly because of the very wide range of variability in the non-athletic group. All performance items showed a superiority of the boys despite that in girls this is usually a period of rapid growth both structurally and functionally. As apparent in fistball throw where reference values were available, both test groups displayed much greater explosive strength than non-athletic children. A part of this higher performance is apparently also due to their accelerated maturation which was by about 8 months ahead of calendar age.

To find out if it was this acceleration indeed that contributed to better performance and, in some dimensions of physique, to larger values, we related all measurements and the plastic index to bone age. As seen in Table 1, all the physical dimensions and also several of the performance items had a significant connection with skeletal age. This challenged us to look for a means of estimat-

ing bone age for this age-group of athletic children by including these parameters in a multivariate regression. It turned out, however, that behind a great number of relations a common factor was operative. The main contributor to this common effect was the relation between bone age and stature. As shown by the respective right side columns in Table 1, the exclusion of the effect mediated through body height markedly reduced the coefficients for both motor performance and body dimensions.

Table 1

Full and partial correlation coefficients of measured parameters with bone age*

Boys (N = 16)		Dimensions	Girls (N = 26)	
full	partial		full	partial
.45	.42	Decimal age	.46	.23
.59	.33	Cooper test	.27	.04
—.45	—.09	60 m run	—.60	—.41
.54	.08	Long jump	.68	.45
.62	.23	High jump	.82	.54
.47	—.02	Fistball	.54	.20
.83	—	Height	.80	—
.77	.39	Weight	.78	.34
.77	.34	Chest width	.66	.27
.75	.16	Chest depth	.67	.18
.77	.18	Biacromial width	.75	.39
.82	.55	Forearm girth	.72	.44
.78	.41	Hand circumference	.86	.61
.85	.47	Plastic index	.83	.54
.50	.51	r (5%)	.39	.40
.62	.64	r (1%)	.49	.50

* Partial correlation excluded the variability in stature. Bottom rows indicate tabular values of the linear correlation coefficient on the 5 and 1 per cent levels of significance with degrees of freedom n-2 (full) and n-3 (partial).

When variability of stature, as one of the main signs of developmental status, is held constant, lower arm girth in the boys and hand circumference in the girls remained qualified for predicting bone age by non-radiological means. Since lower arm girth as a predictor for the boys was only slightly better and the gain in accuracy by using it in place of hand circumference was negligible, we employed the latter for both sexes (Table 2). Accordingly, to provide the possibly simplest and easiest way for assessing biological age, stature, hand circumference and chronological age expressed in decimal years were eventually included in the multivariate prediction equations. All the three predictor variables are easily measurable, and may be used to advantage by coaches, too.

The drastic drop in the correlations between bone age and motor performance due to the exclusion of variability in stature supports the assumption that functional improvement resulting from regular training in motor skills may have a larger share among the factors contributing to athletic proficiency than merely structural advantage. Accelerated maturation will anyway come to an

Table 2

Estimation of bone age in track and field athletes of 10 to 13 years of age: Sex-dependent formulae to predict bone age

BOYS

$Y = 0.084ST + 0.608HC + 0.498DA - 17.496 \pm 0.508; R = 0.980$

GIRLS

$Y = 0.034ST + 0.562HC + 0.362DA - 6.720 \pm 0.481; R = 0.888$

where
Y = bone age in yrs;
ST = body height in cm;
HC = hand circumference in cm;
DA = chronological age in decimal yrs.;
variability is scatter around regression line, and
R = multiple linear correlation coefficient.

end in the long run. Until better means of prediction are developed, such simple ways of assessing developmental age may serve coach and consulting kinanthropometrist alike in avoiding mistakes when children are selected for competitive athletics.

Acknowledgement: For the wrist X-rays and their evaluation we are indebted to the Radiological Department of the Tolna County Hospital, Szekszárd.

REFERENCES

Conrad, K. (1963): *Der Konstitutionstypus.* Springer, Berlin.
Greulich, W.—Pyle, S. (1959): *Radiographic Atlas of Skeletal Development of the Hand and Wrist.* — Stanford University Press, Stanford, Calif.
Mészáros, J.—Mohácsi, J. (1978): A gyermekek és serdülőkorúak fejlődésének összefüggései az iskolai testneveléssel. — (Rektori pályázat.) Magyar Testnevelési Főiskola, Budapest.
Szmodis, I.—Mészáros, J.—Szabó, T. (1976): Alkati és működési mutatók kapcsolata gyermek-, serdülő és ifjúkorban. — Testnevelés- és Sportegészségügyi Szemle, *17;* 255—272.
Weiner, J. S.—Lourie, J. A. (Eds) (1969): *Human Biology — A Guide to Field Methods.* IBP Handbook 9. Blackwell, Oxford.

Authors' addresses: Szabó Tamás
Central School of Sports
H-1146 Budapest, Istvánmezei út 3.
Hungary

Dr. Mészáros János
Dept. Medicine, Hungarian University of Physical Education
H-1123 Budapest, Alkotás u. 44.
Hungary

Table 2

Estimation of [illegible] to [illegible] of [illegible] dependent [illegible] per litter [illegible] age

1974

Y = [illegible]

1975

Y = [illegible]

where

[illegible]

Anthrop. Közl. *24;* 269–275. 1980.

INDICES OF PHYSIQUE AND PERFORMANCE IN PREPUBERAL SWIMMERS

by I. SZMODIS and J. MÉSZÁROS

(Central School of Sports, Budapest, Hungary; Department of Medicine, Hungarian University of Physical Education, Budapest, Hungary)

Abstract. Two groups of prepuberal swimmers (10 boys and 17 girls) with a training history of 2.5 to 3 years were studied three times in three consecutive years from the age of 10 to 12. The purpose was to follow physical development and disclose the relations, if any, between performance and physique. To this end seven body dimensions and swimming scores at the second and third observations were recorded, CONRAD's metric and plastic indices and correlation coefficients were calculated. Boys exceeded in some, girls in most dimensions the comparable non-athletic reference groups of earlier and recent origin. Swimming scores correlated only with hand circumference in the girls and with hand circumference, chest breadth, shoulder width, weight, height and plastic index in the boys. Though correlations of performance with physique became closer with age, also functional aspects have to be considered in explaining improvement in swimming.

Key words: Physique, performance, swimming performance, prepuberal swimmers, sex-dependent traits of physical development.

Introduction

In dealing with athletic youth swimming is an area of particular interest since competitive engagement and success in it too occur at a relatively young age. Our purpose in this work was to study male and female course of development in a group dedicated to this sport and the relationships that may exist between performance and body dimensions of young swimmers.

Material and Methods

The subjects were 10 boys and 17 girls having a training history of 2.5 to 3 years of swimming. This case number might appear very low, but it is not a negligible fraction of this age group of proficient swimmers in Hungary today. Their age ranged from 9.5 to 10.5 when observation began. All of them were observed three times with approximately yearly intervals in between. Observation ended in 1978 when the boys were 11.9 and the girls were 12.1 on the average.

In taking body dimensions IBP suggestions (WEINER and LOURIE 1969) were observed. Of the data metric index as a form factor and plastic index as a robustness factor (CONRAD 1963) were calculated. Performance scores relying on the scoring system of the Hungarian Swimming Federation were recorded at the second and third observations and were related to all observed parameters of physique.

Results and Discussion

All of our subjects lived in the capital, and also the two reference groups of non-athletic children were inhabitants of Budapest. EIBEN et al. (1971) carried out their measurements in 1968/69 while the data reported by the author mentioned second above (MÉSZÁROS and MOHÁCSI 1978) refer to more recent years. Except for body weight, reference data significantly differ from one another. The boy swimmers' weight did not differ from reference data (Fig. 1), and their stature differed only at the second and third observations from the report of EIBEN and collaborators. Their shoulder width only differed from earlier data. Transverse diameters and girths of the extremities tended to follow the slightly upward concave line of weight increase. Yearly increments were always significant on a 1% level except for the metric and inverse ponderal indices (Fig. 2), which showed a peak in body linearity at 11 years of age and

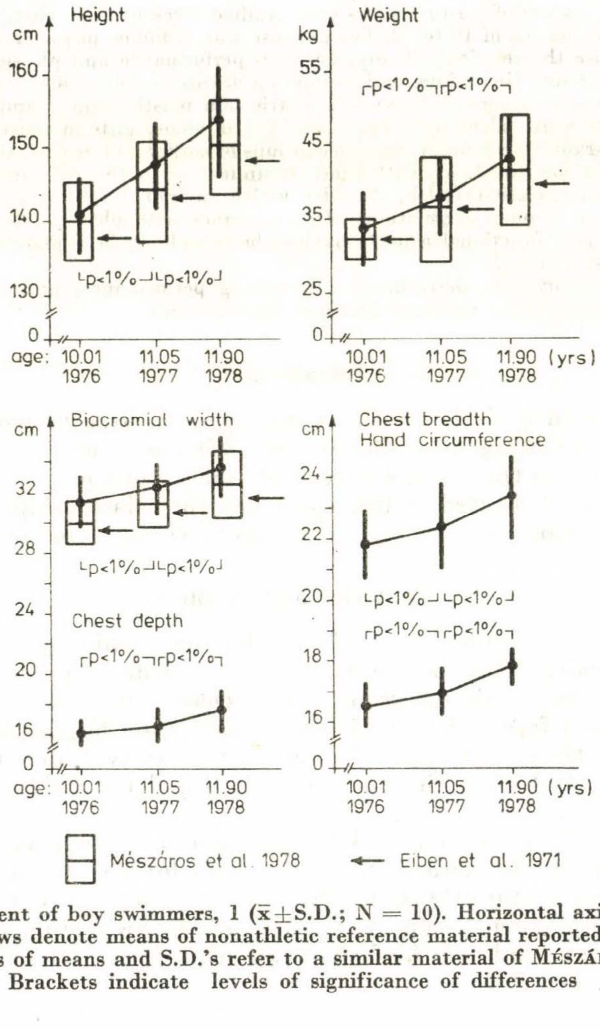


Fig. 1: Development of boy swimmers, 1 ($\bar{x} \pm$S.D.; N = 10). Horizontal axis is that of time and age. The arrows denote means of nonathletic reference material reported by EIBEN et al. (1971). The frames of means and S.D.'s refer to a similar material of MÉSZÁROS et al. (1978). Brackets indicate levels of significance of differences

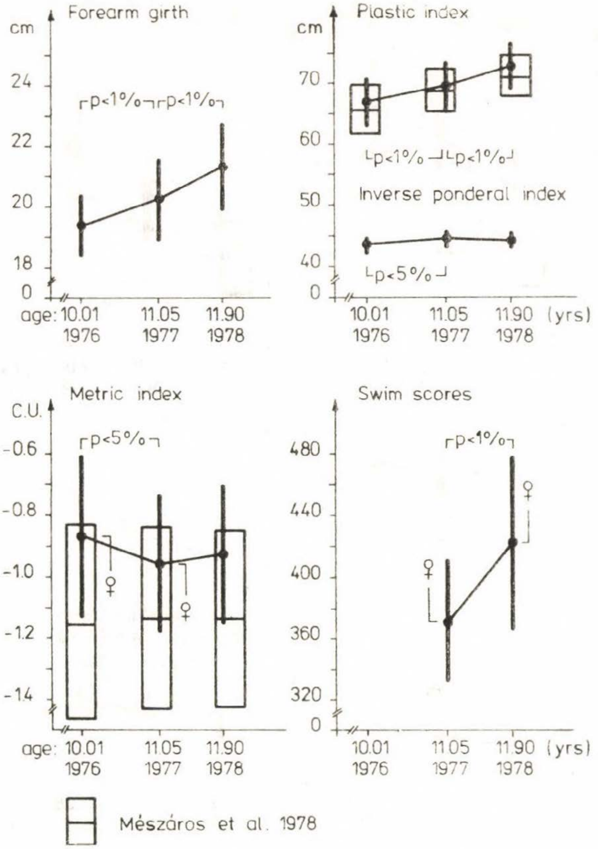


Fig. 2:. **Development of boy swimmers, 2 ($\bar{x}\pm$S.D.; N = 10). Arrows pointing to the female sex symbol refer to significant differences from the girl swimmers. Other symbols and notation agree with that in Fig. 1. C.U.: Conrad units of the leptomorphy-pyknomorphy scale. A more linear body build is denoted by more negative values in the metric index and by larger numbers in the inverse ponderal index**

a slow decrease in it later. Though swim scores improved considerably, the boys' performance was much inferior to that of girls.

The pattern of growth in the girls was slightly different (Figs 3 and 4). All comparable dimensions were greater than the reference data. While their stature ran along an upward, slightly convex line, weight increase had an opposite curvature. Neither of these trends was followed, however, by the other dimensions most of which had an almost straight course with significant yearly increments. Since the girls' performance was markedly better, it is interesting to note that none of the body dimensions differed between the two sexes and the girls had a significantly more leptomorphic build. On the other hand, while peak body linearity in the boys was reached by a relatively steep change, the girls showed — after a plateau between 10 and 11 — a turn toward roundness between 11 and 12 years of age. This and the upward con-

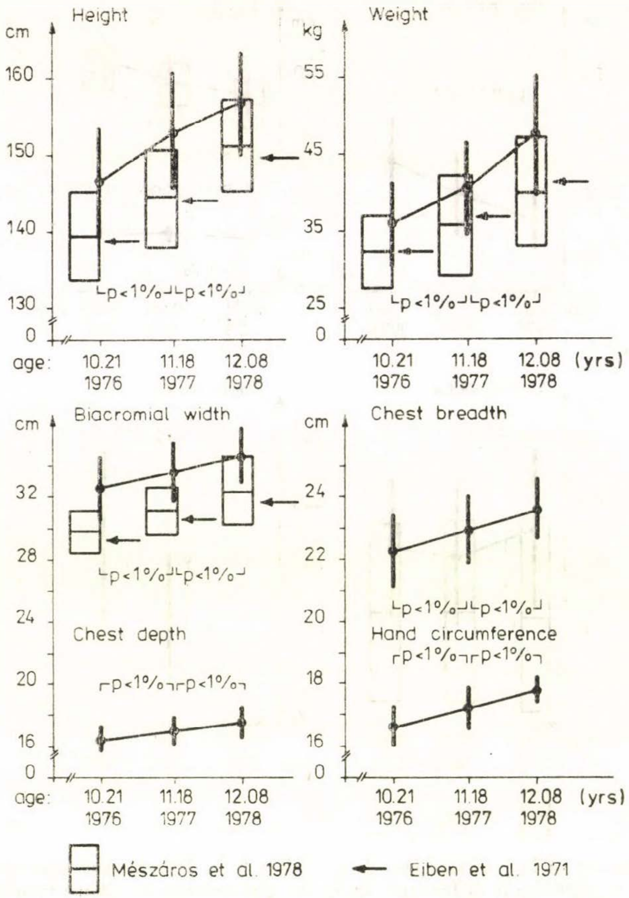


Fig. 3: **Development of girl swimmers, 1 ($\bar{x} \pm$S.D.; N = 17). Symbols, notation and abbreviations conform to those in Fig. 1**

vexity of the stature line seem to forecast the earlier termination of female development.

There are some signs — at least in the stature of young adults — that the secular trend of increasing height is now levelling off in Hungary, too. This may be of course a transitory phase as well, because in the younger age-groups differences from the 1968 reference data are still present, as shown for some dimensions. In regard of athletic groups one should consider selection effects, too, because structural advantage is believed to associate with better performance.

The relationship of body parameters to swimming performance (Figs 5 and 6) became closer with age, though some in the boys and most in the girls failed to reach the level of significance even later. Beyond the marked and striking difference in the number of dimensions significantly related to swim scores it was more surprising that the girls showing a superior performance had

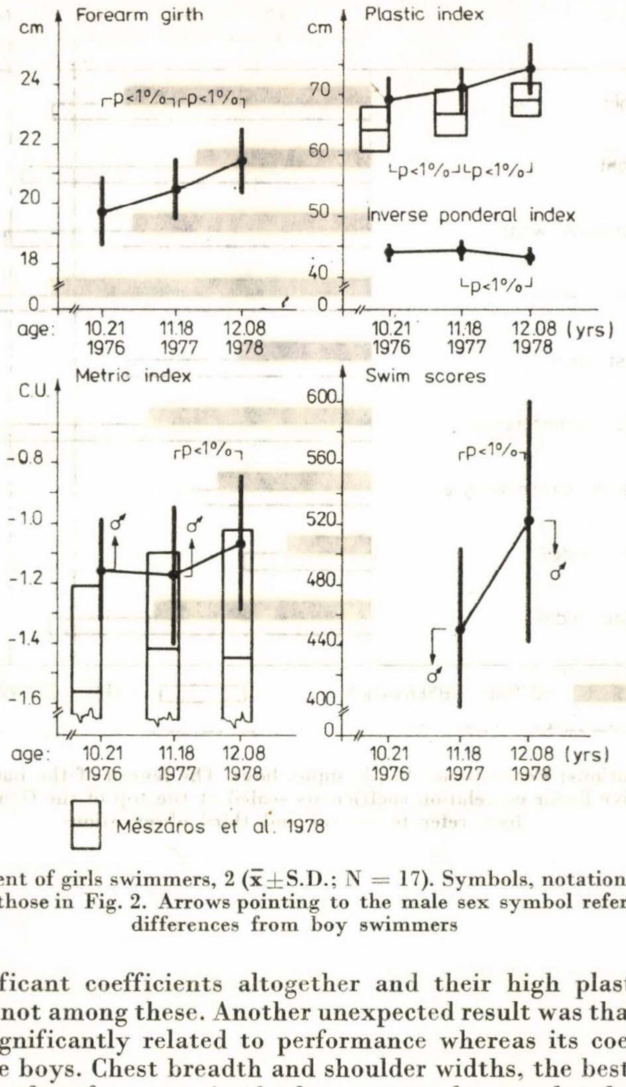


Fig. 4: Development of girls swimmers, 2 ($\bar{x} \pm$S.D.; N = 17). Symbols, notation and abbreviations conform to those in Fig. 2. Arrows pointing to the male sex symbol refer to significant differences from boy swimmers

only two significant coefficients altogether and their high plastic index of robustness was not among these. Another unexpected result was that chronological age was significantly related to performance whereas its coefficient was negligible in the boys. Chest breadth and shoulder widths, the best and second best predictors of performance in the boys, were also unrelated to the girls' scores.

We can offer only a tentative explanation for these unexpected results. In view of the taller than reference stature of these girls, they might have been accelerated as well. This assumption, however, is apparently invalidated by the correlation of chronological age, which would be decreased rather than increased by earlier maturation. Thus their tall stature may be a selection effect rather. In addition, this period of life is usually one of conspicuous gain in strength, speed and coordination in athletic girls. These faculties are likely, then, to influence performance to the same, if not greater extent, as the underlying biomechanical structure, though the importance of the latter cannot be neglected either.

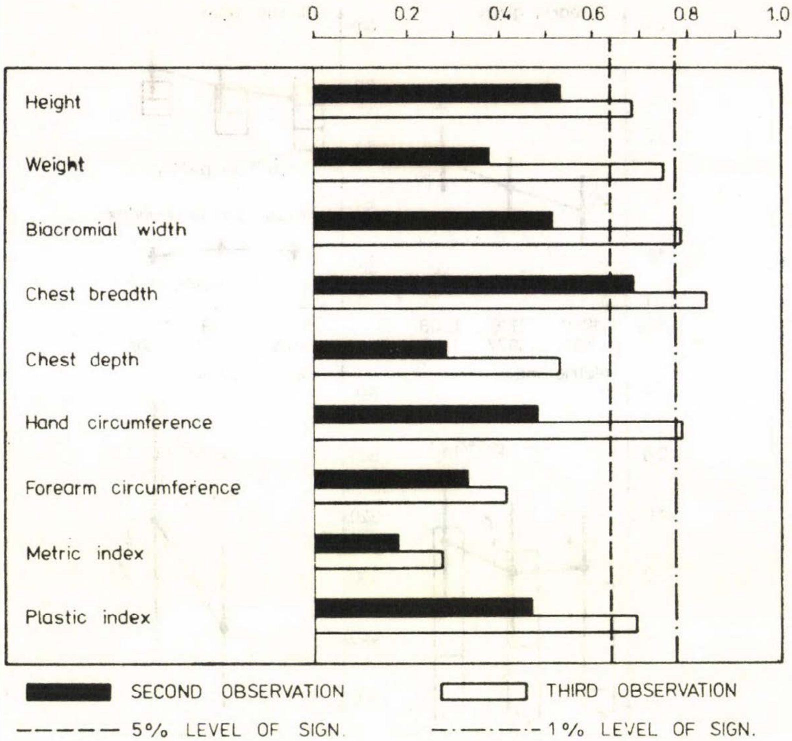


Fig. 5: **Correlations: Performance to physique, boys. The length of the bars is proportionate to the respective linear correlation coefficients scaled at the top of the figure. Bold and open bars refer to second and third observations**

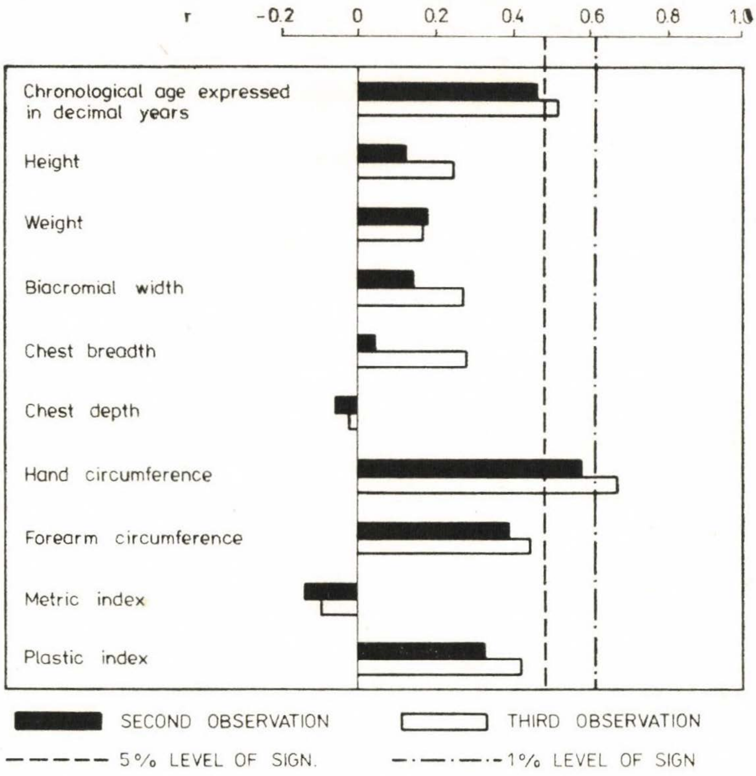


Fig. 6: **Correlations: Performance to physique, girls. Notation conforms to that in Fig. 5**

REFERENCES

CONRAD, K. (1963): *Der Konstitutionstypus.* — Springer, Berlin.

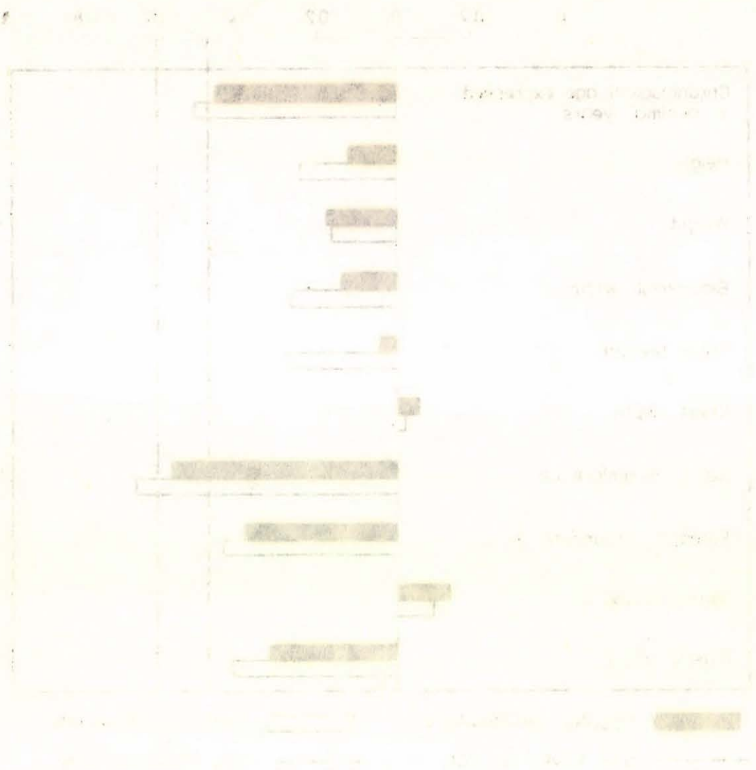
EIBEN, O. G.—HEGEDŰS, GY.—BÁNHEGYI, M.—KIS, K.—MONDA, M.—TASNÁDI, I. (1971): *Budapesti óvodások és iskolások testi fejlettsége (1968—1969).* — KÖJÁL, Budapest.

MÉSZÁROS, J.—MOHÁCSI, J. (1978): A gyermekek és serdülőkorúak fejlődésének összefüggései az iskolai testneveléssel. — (Rektori pályázat.) Magyar Testnevelési Főiskola, Budapest.

WEINER, J. S.—LOURIE, J. A. (Eds) (1969): *Human Biology — A Guide to Field Methods.* IBP Handbook 9. — Blackwell, Oxford.

Authors' addresses: Dr. SZMODIS IVÁN
Central School of Sports
H-1146 Budapest, Istvánmezei út 3.
Hungary

Dr. MÉSZÁROS JÁNOS
Dept. Medicine, Hungarian University of Physical Education
H-1123 Budapest, Alkotás u. 44.
Hungary



Hungary

Anthrop. Közl. *24;* 277–282. 1980.

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 skinfold data) — hand strength, where the correlations are closer. The authors discute 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	
x̄	S.D.		x̄	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		
x̄±SD	r	p<		x̄ ± 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 $\bar{x} \pm SD$	r	p<
Boys				
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
Girls				
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, PAŘÍZKOVÁ 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 hallgatónők testsúly, 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. Drustva Jug., *11;* 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

Anthrop. Közl. 24; 283—289. 1980.

THE BODY COMPOSITION, FAT PATTERN AND SOMATOTYPE OF YOUNG FEMALE GYMNASTS AND SWIMMERS

by M. S. YUHASZ, R. B. EYNON and S. B. MACDONALD

(Faculty of Physical Education, University of Western Ontario, London, Canada)

Abstract. High performance young female gymnasts and swimmers were the subjects of an anthropometric study. The 13 female gymnasts average age 14.3 years were shorter and lighter than the young swimmers and their peer population. The 17 female swimmers average 11.6 years were taller, heavier than their peer population and fatter than the young gymnasts. There was no difference in their body fat pattern, nor in their body type.

Key words: Physique, body composition, fat pattern, somatotype, female gymnasts, female swimmers.

Introduction

Greater numbers of young female athletes are achieving national and international prominence in sport. This has become conspicuous in swimming and gymnastics at the last three Olympic games. Are these athletes different than their non-athletic peers at an early age? Is there a selectivity process for each sport, and what is the effect of early, consistent and heavy physical activity upon these athletes? This study concentrates on the body composition and body type of female gymnasts and swimmers.

Methods

The anthropometric measurements were taken on all subjects in the University of Western Ontario laboratory, using the MOGAP procedures (BORMS et al. 1977). Harpenden calipers were used for diameter measurements; a steel tape circumeter that exerted constant tension for the circumference measurements and the Harpenden cali per or the subcutaneous fat thickness measurements (YUHASZ 1978). Total body fat was calculated from the equation of BROZEK and KEYS (1963) and body density determined from underwater weighing. Residual air was measured by helium dilution. The somatotypes were objectively determined using the Heath—Carter system (PAŘÍZKOVÁ 1977).

Subjects

The 13 female gymnasts were members of two different clubs in Ontario, and were among Canada's best gymnasts. One of the girls was a gold medalist at the 1978 Commonwealth Games. They ranged in age from 11 to 16 and had been involved in competitive gymnatics from 4 to 8 years. The 17 female swimmers ranged in age from 10—12 years and were the top performers for their age in the London, Ontario Club (MATHESON 1977). They averaged 14 months competitive swimming experience and their swimming times were among the best in Ontario. The 8 college gymnasts and 14 college swimmers of national caliber were selected from the University of Western Ontario teams over 2 years of competition. All athletes were measured near the peak of their competitive season.

Results

Body size

The gymnasts, although older by nearly 3 years were slightly shorter and lighter than the swimmers (Table 1). The gymnasts were significantly below the Canadian norms for height and weight at their age, whereas the swimmers were significantly above the mean Canadian values for their height and weight.

Table 1

Body size of female gymnasts and swimmers

Groups		Age (yr)	Height (cm)	Weight (kg)
Canadian gymnasts	(N = 13)	14.3	153.1	41.8
Canadian norms		14	160.0	49.1
College gymnasts	(N = 8)	21.1	154.7	55.0
Mexico Olympics	(N = 21)	17.8	156.9	49.8
London/Ont. swimmers	(N = 17)	11.6	154.4	43.6
Canadian norms		12	145.8	38.2
College swimmers	(N = 14)	21.6	167.3	63.3
Mexico Olympics	(N = 28)	16.3	164.4	56.9

With gymnasts the trend appears to indicate very little change in stature, from young (1—4 cm) to college-age gymnasts or Olympic competitors (DE GARAY et al. 1974). With swimmers, the trend indicates a continuing increase in stature (10—13 cm) and in weight (13—20 kg).

Body composition

Young gymnasts are significantly lower in total body fat than swimmers (9.1 to 16.2%) and continue to hold approximately a 6% differential at each age and level (Table 2). The young 11.6 year old swimmers lean body mass is just under the 14-year-old gymnasts but there is every indication that the young female swimmers have a significantly larger lean body mass when compared to gymnasts of their own age and with the Mexican Olympic gymnasts (Table 3). The rate of increase in lean body mass for gymnasts from age 13 to 17 is relatively small (3 kg), while the rate of increase of lean body mass for swimmers from age 12—16 is relatively large (10 kg).

Table 2

Body composition of female gymnasts and swimmers (number of athletes investigated as in Table 1)

Groups	% Fat	% Lean	Fat mass (kg)	Lean mass (kg)
Canadian gymnasts	9.1	90.9	3.8	38.0
College gymnasts	13.5	86.5	7.4	47.6
London/Ont. swimmers	16.2	83.8	7.1	36.5
College swimmers	19.1	80.9	12.1	51.2

Table 3

Body composition of young female swimmers

Characteristics	London Club		Ontario swimmers (1976)	Berlin Novak (1973)	U.W.O. College (1976)	Mexico Olympics
	(1978)	(1979)				
Number	12	12	8	8	14	28
Age (yrs)	11.8	12.8	14.6	14	21.6	16.3
Weight (kg)	43.2	50.4	54.0	48.2	63.3	56.9
Height (cms)	154.4	162.5	153.5	158.1	167.3	164.4
% Fat	16.2	16	13.5	17.0	19.1	16 est.
Fat mass (kg)	7.1	8.1	7.3	8.2	12.1	9.1
% Lean	83.8	84	86.5	83.0	80.9	84
Lean body mass (kg)	36.5	42.3	46.7	40.0	51.2	47.8

Body fat pattern or configuration

The variation in thickness of the subcutaneous or external coat of fat and its consequent pattern or configuration appears to be hereditarily determined (MacDonald 1978). It differs between the sexes and among individuals. Specific forms and types of activity appears not to affect the fat pattern. The difference in pattern between the sexes seems to evidence itself after puberty, suggesting that the sex hormones influence the deposition of fat (Edwards 1951).

A visual graphical representation of the subcutaneous fat thicknesses can be plotted using raw score values to give an absolute pattern, or the raw score values can be converted into their Z score equivalents to give a relative pattern. The relative pattern eliminates the differences in configuration due solely to the amount of fat. The reference standard in this case was a relatively large sample of female college athletes. The group mean is the plot at zero standard score.

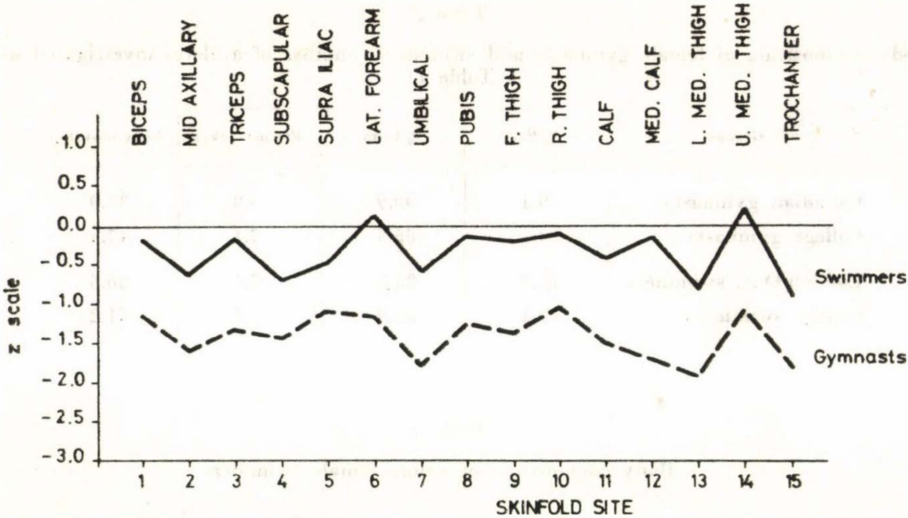


Fig. 1: **Relative fat patterns of young gymnasts and swimmers**

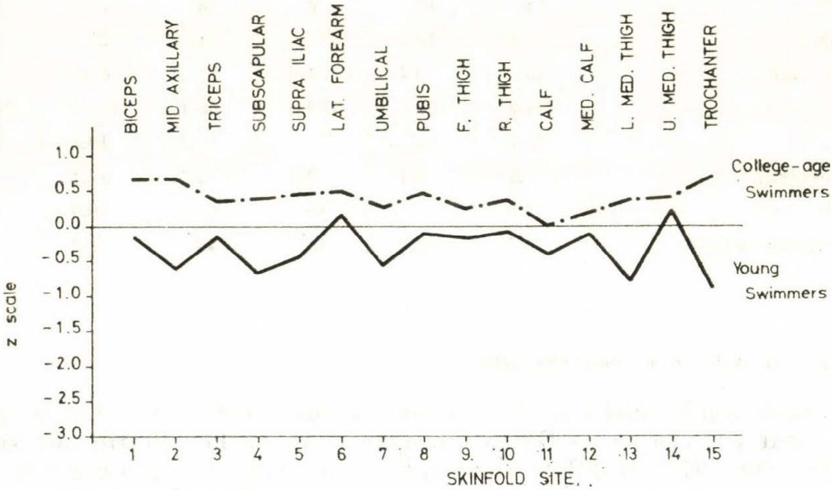


Fig. 2: **Relative fat patterns of young and college swimmers**

The 15 site fat pattern plot for the young gymnasts and swimmers (Fig. 1) show no appreciable difference. Gymnasts have less fat at each site but the configuration is essentially the same. However, young swimmers differ from the college-age swimmers (Fig. 2), and young gymnasts differ from the college-age gymnasts (Fig. 3). The fat pattern of college gymnasts and swimmers approaches similarity, but the pattern plots differ from each other. This may be due in part to the relatively small sample size (Fig. 4).

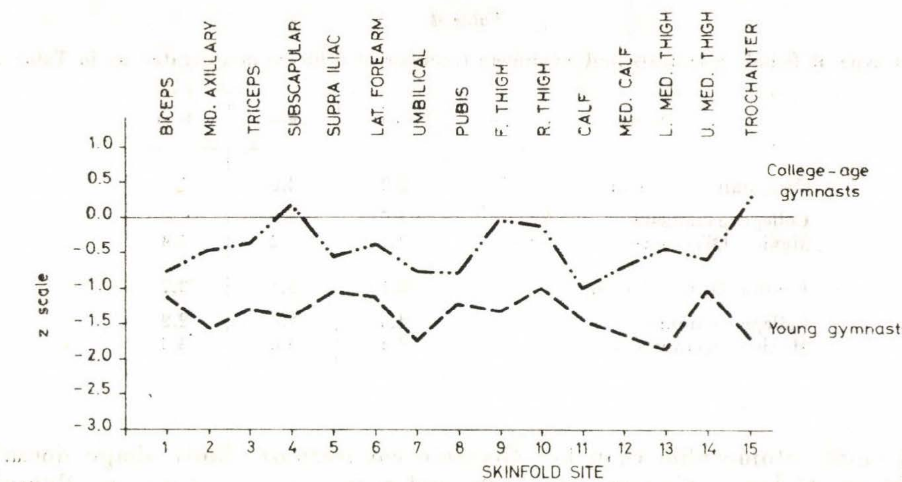


Fig. 3: **Relative fat patterns of young and college gymnasts**

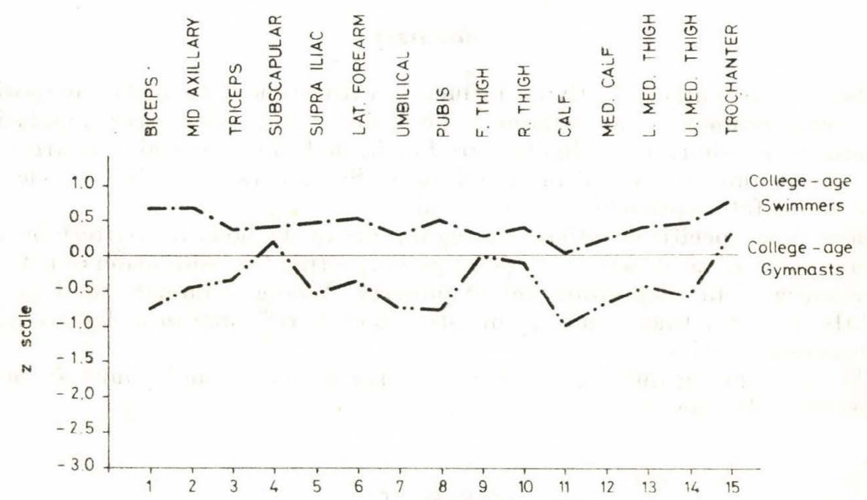


Fig. 4: **Relative fat patterns of college gymnasts and swimmers**

Somatotype

Olympic gymnasts and swimmers don't differ from each other. They exhibit a central or medial somatotype 3—4—3. Nor do they differ much from a reference woman 4.5—3.5—3.0. The young gymnasts is less endomorphic, and slightly more ectomorphic and hasn't yet achieved the level of mesomorphy, due to age or maturity and intensive training. It may also show a more recent trend to lower levels of fatness and the young swimmer is less mesomorphic

Table 4

Body type of female gymnasts and swimmers (number of athletes investigated as in Table 1)

Groups	Endo	Meso	Ecto
Canadian gymnasts	2.0	3.0	3.8
College gymnasts	3.7	4.3	1.2
Mexico Olympics	2.7	4.2	2.8
London/Ont. swimmers	3.1	3.1	3.7
College swimmers	4.5	2.6	2.2
Mexico Olympics	3.4	4.0	3.0

and more ectomorphic than her Olympic counterpart. Body shape doesn't differentiate between young gymnasts and swimmers, nor between Olympic gymnasts and swimmers (Table 4).

Summary

There is an early selectivity influence with respect to body composition for young gymnasts and swimmers. They differ from their peer populations. Gymnasts are shorter and lighter, are low in body fat, have high relative lean body mass and are medial in ectomorphy. Swimmers are taller, heavier and have body fat approaching normal values.

There is no specific or differentiating feature in the body fat pattern between young gymnasts and swimmers, perhaps supporting the contention of a universal pattern of fat deposition before puberty. Young swimmers tend to have slightly more fat than young gymnasts, which is reflected in a slightly higher endomorphic rating.

The outstanding difference between young gymnasts and young swimmers is one of body size.

REFERENCES

Borms, J.—Hebbelinck, M.—Carter, J. E. L.—Ross, W. D.—Yuhasz, M. S.—Lariviere, N. (1977): Standardization of basic anthropometry in Olympic athletes — the MOGAP procedure. — *Methods of Functional Anthropology*. Symposium Proceedings, Prague.

Brozek, J.—Keys, A. (1963): Densitometric analysis of body composition: Revision of some quantitative assumptions. — Ann. N. Y. Acad. Sci., *110;* 137.

Edwards, D. A. W. (1951): Differences in the distribution of subcutaneous fat with sex and maturity. — Clin. Sci. *10;* 305.

De Garay, A. L.—Levine, L.—Carter, J. E. L. (1974): *Genetic and Anthropological Studies of Olympic Athletes.* — Academic Press, New York.

MacDonald, S. B. (1978): *The heritability of relative body fat pattern* (M. A. Thesis). University of Western Ontario, London/Ont.

Matheson, L. A. (1977): *Selected physiological, anthropometric and skill variables contributing to success in 10—12-year-old female competitive swimmers* (M. A. Thesis). University of Western Ontario, London/Ont.

NOVAK, L. P. (1973): Maximal oxygen consumption, pulmonary function, body composition and anthropometry of adolescent female athletes. — Int. Z. Angero. Physiol., *31;* 103—119, 1973.
PAŘÍZKOVÁ, J. (1977): *Body Fat and Physical Fitness.* Martinus Nijhoff, Hague.
YUHASZ, M. S. (1978): *Physical Fitness Manual.* — University of Western Ontario.

Author's address: Prof. Dr. MICHAEL S. YUHASZ
Faculty of Physical Education
University of Western Ontario, Thames Hall
London/Ont. N6A 3K7
Canada

Anthrop. Közl. 24; 291—294. 1980.

DR. VÉLI GYÖRGY
1895—1980

Néhány éve az Anthropologiai Közlemények különszámával (19. évfolyam 2. füzete, 1975) köszöntöttük az akkor 80 éves VÉLI GYÖRGYöt. Részletesen bemutattuk életpályáját, amelyben a gyermekek növekedését, testi fejlődését, érését és az ezekben megmutatkozó variációkat vizsgáló és az alapvető biológiai törvényszerűségeket kereső humánbiológus, ill. a gyógyító—megelőző tevékenységet folytató gyermekgyógyász és oktató—nevelő iskolaorvos érdeklődése és szemlélete ötvöződött. Azt reméltük akkor, hogy még sokáig tevékenykedhet köztünk. Az egyre súlyosbodó betegség azonban fokozatosan legyűrte szervezetét, és 1980. október 31-én szíve örökre megszűnt dobogni. Pedig mennyi terve volt még!

Élete utolsó éveiben összefoglalta életművét.

Munkássága kezdetét az 1928-ban végzett első kaposvári keresztmetszeti növekedésvizsgálata jelentette. Erről írott dolgozatának alcíme „Összehasonlító tanulmány" volt, és akkor ez volt benne az új: nemcsak saját vizsgálati eredményeit közölte, hanem azokat beleillesztette az akkoriban megjelent hasonló tanulmányok rendszerébe. E tanulmányát később többen is méltatták (EIBEN 1952-ben, MALÁN 1961-ben, FARKAS 1961-ben).

Az 1947/48. tanévben megismételte e vizsgálatát, és azt kutatta, hogy menynyire befolyásolta a második világháború és az annak nyomán jelentkező sok élelmezési nehézség a gyermekek testi fejlődését. Eredményeit szinte azonnal közölte, hogy másokat is hasonló vizsgálatokra ösztönözzön, részben, hogy eredményei összehasonlításhoz jussanak, részben, hogy az időközben felvetődött, nyitott kérdésekre választ kaphasson. Felhívása ilyen értelemben eredménytelen maradt, így a hazai antropológiai irodalomban az övé az egyetlen közlés a gyermekek növekedésére gyakorolt háborús hatások kutatásában. Kimutatta, hogy Kaposvárott a két említett vizsgálata között észlelhető differenciák 1 éves időszakokra átszámítva 2—3-szor kisebbek, mint a BRAUNHOFFNER által Budapesten kapott értékek. Ezt úgy magyarázta, hogy BRAUNHOFFNER 1928-ban és 1934-ben, míg ő 1928-ban és 1947-ben végezte vizsgálatait. A budapesti vizsgálat eredményeit már nem befolyásolta az első világháború, míg az 1947. évi kaposvári vizsgálat eredményeiben a második világháború ártalmai nagyon is éreztették káros hatásukat. E tanulmány eredményeit értékelve KONTRA (1968) kiemelte, hogy VÉLI már több évvel BENNHOLDT-THOMSEN 1954. évi tanulmányának megjelenése előtt kimutatta, hogy a retardáció kiküszöbölése milyen jelentős. További szerzők idézték elismeréssel munkáit, ill.

munkásságát: FARKAS 1961-ben, KUN 1962-ben, LIPTÁK 1969-ben. VÉLI GYÖRGY büszke volt ezekre a kollegáktól kapott elismerésekre, hiszen a magányosan dolgozó kutatónak ezek erkölcsi elismerést jelentettek.

Érdeklődéssel foglalkozott az ún. „akceleráció" kérdésével: „Felvetődik a kérdés, hogy valódi növekedésről, vagy egyszerűen a növekedés meggyorsulásáról van-e szó" — írta 1948-ban. Sorozási jegyzőkönyvek tömegét dolgozta fel, persze Somogy megye adatai különösen érdekelték. Megállapította, hogy az 1850. és 1935. születési évek közötti testmagasság-különbség évi 0,778 mm vagyis 10 évenként 7,78 mm) volt. Ezzel bizonyította, hogy Magyarországon is van „akceleráció". Mégis, az 1950-es évek elején ezt a közismert tényt nem volt könnyű elfogadtatni. Sokáig őrizte a „Népegészségügy" levelét, amelyben a tanulmányát elutasították. Végül 1954-ben a „Biológiai Közleményekben" látott napvilágot e munkája.

Az 1960-as évek végén újra elővette e témát, és azt vizsgálta, van-e különbség a felszabadulás előtti és utáni növekedés között. Az eredmény őt igazolta: amíg a felszabadulás előtt a növekedés mértéke évenként 0,8 mm volt, addig a felszabadulás után ez évi 1,8 mm-re változott. Ekkor foglalt állást az „akceleráció" kifejezés ellen, és helyébe a BÜRGER által ajánlott „biomorphosist" javasolta. Nagy jelentőséget tulajdonított a környezeti tényezők hatásának.

Elméletének új elemét így fogalmazta meg: „A régebbi felfogás szerint egy bizonyos alapértékből kiindulva különböző izgató hatások eredményeként a magasság bizonytalan értékig emelkedik. Elméletem szerint viszont a magasabbra növés annak a következménye, hogy a törzsfejlődés folyamán kialakult optimumot elhomályosító retardáció a környezeti tényezők fokozatos javulása következtében felszámolódik, és ennek eredményeképpen az akut testmagasság mind közelebb kerül a biológiailag elérhető maximumhoz. A növekedés tehát — számviteli meghatározással — nem „-tól", hanem „-ig". A környezeti tényezők javulása indokolja a kísérő tüneteket is, mint az élettartam növekedése és a halálozási arány csökkenése. Növekszik az emberiség? Nem! Csak az elveszett örökségét pöröli vissza. A kérdés most már csak az, hogy ez a változás a tökéletesedés, vagy a visszafejlődés irányába mutat-e." — Elmélete komoly, pozitív visszhangot váltott ki (HEGEDŰS 1970-ben, JUVANCZ 1975-ben és mások).

Munkásságának egy másik jelentős területe a menarchekort érintette.Az 1956-ban közölt tanulmányának ide vonatkozó 1947/48. évi adataiból THOMA probit-analízissel $m = 13{,}9$ éves menarchekort számított. Ez az első olyan korrekt hazai menarchekor adatunk, amely a ma alkalmazott methodika szerint is érvényes. Ide vonatkozó, több értékes tanulmányát többen méltatták (THOMA 1961-ben, EIBEN 1968-ban). VÉLI GYÖRGY tagja volt az első országos menarchekor-mediánt publikáló munkaközösségnek is.

A testi fejlődés és a menarche között pozitív korrelációt mutatott ki. Leírta, hogy a 13 éves, már menstruáló leányok testmagassága és testsúlya korcsoportjuk statisztikai paramétereinek $\bar{x} + 1s$, míg a 15 éves, még nem menstruáló leányok $\bar{x} - 1s$ értékeit közelítik meg.

Megállapította, hogy a menarchekor hazánkban az 1940-es évek vége óta egyre korábbra kerül, továbbá azt is, hogy a menarche a legnagyobb növekedési és gyarapodási hozamot (ti. a serdülési növekedési lökés csúcsát) követő évben jelentkezik. Ami pedig a végső testmagasságot illeti, leírta, hogy minél előbb jelentkezik az első vérzés, annál inkább kiemelkedik a leánygyermek kortársai közül, de mert ezzel egyidőben hossznövekedése máris lelassul, és rövidesen teljesen leáll, végeredményben alacsonyabb marad, mint a későbbi menarche miatt magasabb szintről induló társai. E közleményének különlenyomatát több, mint ötvenen kérték meg külföldről.

További, számára kedves terület volt az iskolában folyó egészségnevelés, amelyet ő — a korábbi „szexuális felvilágosítás" helyett — már nagyon korán igen korszerűen végzett.

VÉLI GYÖRGY munkássága sok tekintetben úttörő jellegű volt. Mindazt, amit alkotott, saját iniciatívájára, saját erejéből, szerény eszközökkel, de annál több hozzáértéssel, szakszerűséggel és lelkesedéssel tette. Eredményei jelentős visszhangot keltettek itthon és külföldön egyaránt. Legtöbb megállapítása ma már általában elfogadott, a szakmai köztudatba beivódott. Ezért hiányzik annyira nekünk, akik tiszeltük és szerettük őt. Nélkülöznünk kell bölcs tanácsait, kritikus észrevételeit, mindig szeretetteljes humánumát, emberségét.

Emlékét kegyelettel megőrizzük.

Dr. Eiben Ottó

Dr. VÉLI GYÖRGY SZAKIRODALMI MUNKÁSSÁGÁNAK JEGYZÉKE

1924 — *Adatok a liquor cerebrospinalis fagyáspontcsökkenésének vizsgálatához (VÉLI GYÖRGY—PAUNZ JÁNOS). — Magyar Orvosi Archívum, *21;* 138—141.
1936 — A kaposvári óvodás és elemi iskolás gyermekek testméretei. — Iskola és Egészség, *3;* 112—124.
1937 — A pubertás befolyása a szellemi képességek fejlődésére. — Egészség, *51;* 150—154.
1938 — Levél a tanulók egészségügyi epigrammáival. — Egészség, *52;* 79—80.
1948 — Mennyire befolyásolta a háború a gyermekek testi fejlődését? — Népegészségügy, *29;* 667—674.
1950 — Pellagra előfordulásáról. — Orvosi Hetilap, *91;* 975—976.
1953 — Golyva a kaposvári iskolásgyermekek között. — Gyermekgyógyászat, *4;* 311—314.
1954 — Az ember növekedésének egyes kérdéseiről. — Biológiai Közlemények, *1;* 137—147.
— Hozzászólás Varga Béla dr. „A rövidlátás keletkezéséről, gyógyításának és megelőzésének lehetőségeiről" (Szemészet, 1953. 1.) c. munkájához. — Szemészet, *91;* 47—48.
1956 — Újabb tanulmány a tanuló ifjúság testi fejlődéséről. — Biológiai Közlemények, *3;* 97—114.
1957 — A kaposvári és környékbeli, 1927—1936. évi születésű ifjúság növekedéséről. — Anthrop. Közl. *1;* 51—55.
1962 — Hozzászólás Hegedűs György „Gyermekek és gyermekkollektívák fizikai fejlettségének értékelési módszerei" c. cikkéhez. — Népegészségügy, *43;* 92—94.
— Csecsemőgondozás a kaposvári cigányok között. — Élővilág, *7;* 46—47.
1962 — *Über die jahreszeitlichen Schwankungen im Menarchebeginn bei Landmädchen. (VALŠIK, J. A.—VÉLI GYÖRGY) — Acta F. R. N. Univ. Comenianae, Anthropologia *7;* 119—125.
1963 — *A menarche kora Magyarországon. (BOTTYÁN OLGA, DEZSŐ GYULA, EIBEN OTTÓ, FARKAS GYULA, RAJKAI TIBOR, THOMA ANDOR és VÉLI GYÖRGY). — Anthrop. Közl. *7;* 25—39.
— *Age at menarche in Hungarian girls. (BOTTYÁN, O.—DEZSŐ, GY.—EIBEN, O.—FARKAS, GY.—RAJKAI, T.—THOMA, A.—VÉLI, GY.). — Annales Hist.-Nat. Musei Nat. Hung. *55;* 561—572.
1964 — *Magyarországi megfigyelések a havivérzés jelentkezésével kapcsolatban. (BOTTYÁN OLGA—DEZSŐ GYULA—EIBEN OTTÓ—FARKAS GYULA—RAJKAI TIBOR—THOMA ANDOR—VÉLI GYÖRGY). — Élővilág *9;* 16—18.
1967 — Az akceleráció a felszabadulás előtt és után. — Anthrop. Közl. *11;* 25—30.
1968 — A testi fejlődés és a menarche. — Anthrop. Közl. *12;* 161—171.
1969 — Gyermekek testhossz- és testsúly-méretei 0—3 éves korban. — Anthrop. Közl. *13;* 121—142.
— Ahogyan az iskolaorvos látja. — Köznevelés, *25/23;* 31—33.

* Társszerzővel írott tanulmány.

1971 — Menarche, growth and development in Hungary. — Acta Paediatrica Acad. Sci. Hung. *12;* 209—221.

— *A 18—20 éves férfilakosság testi fejlettsége (KÁDÁR PÁL—VÉLI GYÖRGY). — Anthrop. Közl. *15;* 97—112.

1972 — *Az állításköteles korú fiatalok testi fejlettsége (KÁDÁR PÁL—VÉLI GYÖRGY). — Honvédorvos, *24;* 186—195.

— Akceleráció vagy retardáció? — Anthrop. Közl. *16;* 105—114.

— Eiben O., Hegedűs Gy., Bánhegyi M., Kis K., Monda M., Tasnádi I.: Budapesti óvodások és iskolások testi fejlettsége 1968—1969. (Könyvismertetés) — Anthrop. Közl. *16;* 151—152.

1974 — Akceleráció-e a säcularis trend? — Gyermekgyógyászat, *25;* 420—422.

— *Az akceleráció szakaszosságáról (KÁDÁR PÁL—VÉLI GYÖRGY). — Anthrop. Közl. *18;* 105—111.

1976 — A szexuális felvilágosítás visszásságai. — A biológia tanítása, *15;* 82—85.

1977 — *A szekuláris trend 100 éve Somogy megyében (KÁDÁR PÁL—VÉLI GYÖRGY). — Anthrop. Közl. *21;* 93—100.

— *100 Jahre des sekulären Trends in einem Bezirk Ungarns (VÉLI, G.—KÁDÁR, P.). — Acta Paediatrica Acad. Sci. Hung. *18;* 105—112.

1980 — *The changing of height and weight of body during half a century in Hungary (BODZSÁR, B. É.—VÉLI, G.). — Glasnik Antropološkog Drustva Jugoslavije, *17;* 69—75.

Összeállította: *Dr. Eiben Ottó*

 Anthrop. Közl. 24; 295–296. 1980.

A MAGYAR BIOLÓGIAI TÁRSASÁG EMBERTANI SZAKOSZTÁLYÁNAK MŰKÖDÉSE AZ 1980. ÉVBEN

210. szakülés, 1980. március 17.

1. VÁMOS KÁROLY: Emésztőszervrendszeri rendellenességek Magyarországon 1970–1974. között.
2. FARKAS GYULA: *Kiszely István:* A Föld népei, 1. Európa népei című könyvének ismertetése.

211. szakülés, 1980. április 14.

1. FARKAS GYULA–EIBEN OTTÓ: Beszámoló a II. Nemzetközi Auxológiai Kongresszusról (1979. december, Havanna).
2. LENGYEL IMRE: Beszámoló a Royal Society és a Brit Tudományos Akadémia "The emergence of man" című vitaüléséről (1980. március, London).
3. EIBEN OTTÓ: Beszámoló indiai tanulmányutamról.

212. szakülés, 1980. május 5.

1. G. AUE-HAUSER (Wien): Die Lage der Anthropologie in Österreich: Unterricht und Forschung.
2. EIBEN OTTÓ: Szomatotípus a gyermekkorban.
3. PAP MIKLÓS–MOLNÁR VALÉRIA–SZILÁGYI KATALIN–MOLNÁR LAJOS: A színtévesztés populációgenetikai vizsgálata Hajdú-Bihar megyében.
4. PANTÓ ESZTER: A növekedés és érés néhány kérdése serdülőkorú egri leányoknál.

213. szakülés, 1980. május 26.

1. T. BIELICKI (Wrocław): Socio-economic stratification and growth in Poland.
2. B. BODZSÁR ÉVA: A pubertáskor érési folyamatai a leányoknál.
3. BUDAY JÓZSEF: Érzékszervi fogyatékos leányok menarche-korának vizsgálata.

214. szakülés, 1980. október 13.

1. M. DROBNÁ (Bratislava): A szekuláris trend Csehszlovákiában, különös tekintettel a szlovákiai gyermekekre.
2. FARKAS GYULA: Paul Broca, a modern antropológia megalapítója. Megemlékezés halálának 100. évfordulóján.
3. TÓTH TIBOR: Beszámoló az 5. Nemzetközi Finn-Ugor Kongresszusról (1980. augusztus, Turku).
4. LENGYEL IMRE: Beszámoló „A hominizáció folyamata" című szimpoziumról (1980. június Párizs).

215. szakülés, 1980. november 17.

1. Szakosztályi vezetőségválasztás.
2. CSOKNYAY JUDIT: Párválasztási tendenciák Szamosangyaloson (Szabolcs-Szatmár megye) 1880–1970. között.
3. TÓTH TIBOR: Avicenna születésének 1000. évfordulója.

216. szakülés, 1980. december 8.

1. P. RUDAN (Zagreb): Biomedical approach to anthropological research.
2. SZÖLLŐSI ERZSÉBET: Debreceni gyermekek fejlődése 7–14 éves korig szemilongitudinális vizsgálat alapján.
3. CSETE KLÁRA–KÓSA FERENC–FÖLDES VILMOS: Esteraze-D enzimrendszer vizsgálata a szegedi népességben.

E. O.

Anthrop. Közl. 24; 297–299. 1980.

LEAKEY, R. E.–LEWIN, R.: *Origins* (E. P. Dutton kiadás, New York, 1977. 264 oldal; sok, részben színes képpel.)

Közismert tény, hogy az utóbbi évtizedekben a hominid evolúció kutatása számos új eredményt hozott, és ezek széles körű publikálásában az összes tömegkommunikációs eszközök részt vesznek. Ez egyben azt is eredményezi, hogy az e kérdések iránt megnyilvánuló érdeklődés sokszorosa a korábbinak. LEAKEY és LEWIN könyve ennek az igénynek a kielégítésére jelenhetett meg. A szerzők látványosan színes könyvet adtak közre, amelyből mind a szakember, mind a laikus olvasó számos új, hasznos információhoz juthat. A könyvet a magas színvonalú ismeretterjesztő és a szakmai képeskönyv határán lehet elhelyezni.

A könyv 10 fejezetre tagozódik. Az első fejezet az emberiség perspektívái címen a hominid evolúció általános kérdéseit vázolja föl. Érinti a 3 millió éves leleteket, és bemutatja a kutatástechnika módszereit. Kitűnő vázlatokon mutatja be a Föld geológiai és paleontológiai történetét, ill. szemléletes térképeken a hominid evolúció különböző fokán levő csontmaradványok lelőhelyeit szerte a világban. A második fejezet a „legnagyobb forradalom" címszó alatt az evolúciós elméletet, Darwin működését tárgyalja. A harmadik fejezet kitűnő primatológiai áttekintést ad. Különösen a kéz használatának és a térbeli látásnak a kialakulása, ezek kölcsönhatása, általában az életmód változásai érdemelnek itt figyelmet. Jól sikerült a subhumán fázis tárgyalása: külön érdemes kiemelni a Dryopithecus és a Ramapithecus bemutatását. A negyedik fejezet az emberi kezdeteket a korábbi hasonló művekben megszokottól eltérő módon ismerteti: nem a leletek szokásos morfológiai leírását, hanem érdekes primates-etológiai tanulmányt olvashatunk. Nem maradnak adósok azonban a szerzők bizonyos morfológiai leírásokkal sem, éspedig a koponya és a fogazat fejlődéséről kapunk demonstrábilis képet. Az ötödik fejezet azt a régi problémát feszegeti, hogy vajon hol volt az emberiség „bölcsője". Részletesen olvashatunk az 1470-es koponyáról, és jó áttekintést kapunk a Hominid fossziliák datálásának módszereiről. A hatodik fejezet „Afrikától a mezőgazdaságig" címet viseli, és a szerzők itt először a koponyakapacitás fejlődését mutatják be, a *Homo erectus*tól a *Homo sapiens*ig. Ehhez kapcsolódik az eszközök evolúciójának bemutatása. A hetedik fejezet a gyűjtögető, a halász–vadász életmódról, a szocializáció kezdeteiről hoz áttekintést. A nyolcadik fejezet az intelligencia, a nyelv és az emberi értelem problémáit tárgyalja, főleg az agykutatás legújabb eredményei alapján. Kitűnő, ahogyan az agy felépítésének és funkciójának kapcsolatát, az agykapacitás növekedését és a funkciók bővülését, mint a hominid evolúció szép példáját bemutatják. A kilencedik fejezet az ösztönökről, a két nem eltérő életmódjáról, az emberi természet számos megnyilvánulásáról hoz színes anyagot. A Primates köréből és számos természeti nép köréből olvashatunk itt leírásokat. A tizedik fejezet az emberiség jövőjét vázolja fel, a szokások kialakulásával, ill. átalakulásával foglalkozik.

Az 5 oldalnyi Index segít az egyes témák könnyebb megtalálásában. A könyv ábraanyaga a terjedelemnek mintegy 2/5-ét teszi ki. A legtöbb ábra eredeti, nagyon sok a színes fénykép. Mindez nagyon didaktikusan szerkesztett. A szöveg jól olvasható, világos. Ami a könyv szerkezetét illeti: ez is egyfajta megközelítés, kétségkívül sok eredetiséggel.

A könyv kiemelkedő érdeme az evolúciós szemlélet, a sok és színes ökológiai és etológiai leírás. A köny kiállítása luxus színvonalú.

Dr. Eiben Ottó

Bishop, W. W. (ed.): *Geological background to fossil man. Recent research in the Gregory Rift Valley, East Africa.* (Scottish Academic Press Ltd., 1978, 585 oldal).

A Gregory Rift Valley (a kelet-afrikai árok) az 1959-ben előkerült *Zinjanthropus boisei* felfedezése óta a hominizáció kutatásának középpontjába került. Ebből a 40—80 km széles és mintegy 2000 km hosszú geológiai törésvonalból különböző lelőhelyekről (Afar, Omo-völgy, Turkana tó, a kenyai lelőhelyek, Laetolil és Olduvai) több, mint 550 fosszilis Hominida-lelet került elő az utóbbi 20 évben. A kötet, amelynek megjelenését a szerkesztője már nem érhette meg, mert 46 éves korában elragadta a halál, egy 1975-ben, Londonban megtartott szimpozium anyagát tartalmazza.

A paleoantropológiai és az archeológiai kérdések a szimpoziumon csak mellékszereplők voltak, a központban a szerkezeti, a vulkáni, a geofizikai problémák és a Gregory Rift Valley geológiai története volt. Ezekkel a témákkal a kötet első része foglalkozik.

A második részben a paleoökológiai, paleontológiai és ősrégészeti témák szerepelnek. Megtalálható a biosztratigráfia új statisztikus megközelítése és a Hominidák allometrikus vizsgálata, valamint az első kőeszközöket készítő „első geológusok" eszközeinek elemzése.

A harmadik rész a Gregory Rift Valley-re vonatkozó geológiai, geofizikai, sztratigráfiai, geokronológiai, paleoökológiai, valamint a fosszilis Hominidákkal kapcsolatos vizsgálatok eredményeit tartalmazza. Itt most csak ez utóbbiakból emelünk ki néhányat.

Mary D. Leakey és mtsai a Laetolilnál előkerült 13 korai Hominidát elemzik. A leletek 3,59—3,77 millió évesek és a korai Hominidák evolúciójához szolgáltatnak adatokat.

Yves Coppens az Omo völgyben előkerült *Australopithecus aff. africanus*, *Australopithecus aff. robustus*, *Homo aff. habilis* és *Homo aff. erectus* leletek környezetének változásait vizsgálja a Hominidák evolúciójával kapcsolatosan.

Don C. Johanson és mtsai az afari lelőhely geológiai részletezése mellett az itt előkerült Hominidákat is elemzik.

A kötet igen részletesen és széles körűen foglalkozik a Gregory Rift Valley-nek a hominizáció kutatásában betöltött szerepével és fontos kézikönyve lehet mindenkinek, aki ebben a témában érdekelt.

Dr. Gyenis Gyula

Berenberg, S. R. (Ed.): *Puberty. Biologic and psychological components.* (H. E. Stenfert Kroese B. V., Leiden—Martinus Nijhoff B. V. Publishers, The Hague, 1975. 320 oldal, ábrákkal. Ára: Dfl 68,—)

A kötet a Josiah Macy jr. Foundation és a Centre International de l'Enfance 1974. decemberében Párizsban rendezett konferenciájának anyagát adja közre. J. Z. Bowers, az Alapítvány elnöke előszavában hangsúlyozza, hogy a pubertásról és az adoleszcenciáról meglevő ismereteink hiányosak, és ezen csak folyamatos orvosbiológiai kutatásokkal és orvosképzéssel lehetne segíteni. Autentikus diszciplína e téren egy speciális és komplex orvosi megközelítés lehetne, amely széles körű kutatásokat folytatna minden idekapcsolódó kérdésben. Kiemelkedően fontosnak tartja ezek közül a biológiai és pszichológiai fejlődés közötti kapcsolat elemzését.

A kötet 27 tanulmányt közöl, amelyeknek terjedelme, a témában való elmélyedésük mértéke nagyon különböző.

Grumbach szinte monográfikus alapossággal írja le a pubertás fellépését bevezető és kísérő endokrin folyamatokat. Referátumában kapcsolódik Van Der Werff Ten Bosch, aki a pubertás neurohormonális szabályozását tárgyalja. Ő adja a *pubertás* meghatározását, amelyet a konferencia is magáévá tett: a testfejlődésnek az a szakasza, amelynek során a gonádok hormonkiválasztása olyan szintre jut el, hogy az a nemiszervek meggyorsult növekedését és a másodlagos nemi jellegek megjelenését okozza. A hormonális folyamatok elemzésével foglalkoznak még további tanulmányok: Job és munkatársai, Sizonenko, Forest és munkatársai, Everett. Smith a kérdés táplálkozásbiológiai oldalát vizsgálja. Hangsúlyozza, hogy a serdülőkre jellemző intenzív anyagcsere és gyors növekedés nagy kalóriabevitelt és az esszenciális tápanyagok állandó jelenlétét követeli meg. Valóban tűrhetetlen, hogy a gyermekek reggeli nélkül menjenek az iskolába.

Odell és munkatársai a nemi érés, a szexualis funkciók érését tárgyalják az endokrinológia oldaláról. Ide kapcsolódik Carballo és Engström tanulmánya. Prader, a kérdés elsőszámú szaktekintélye, a testisek növekedéséről ír.

A következő néhány dolgozat a pubertáskori testösszetételt, ill. az abban bekövetkező változásokat vizsgálja (Faulkner, Forbes), ill. az obesitassal foglalkozik (Heald és Khan, Knittle, Morgenthan). Tematikailag ehhez kapcsolódik a funkciók fejlődését és a testgyakorlás hatását (PAŘÍZKOVÁ), ill. a fizikai fitséget (HEBBELINCK és BORMS) elemző két tanulmány.

Ezután olvashatunk az intelligencia fejlődéséről (PEEL és LIT), az intelligencia és a megismerés (WALL), ill. a fiziológiai és a mentális fejlődés kapcsolatáról (KOHEN-RAZ). Az emocionális érés és magatartás kérdésével két különböző szerző is foglalkozik (FRISK, FRIEDMAN).

Két tanulmány tárgyalja a pubertáskori növekedésben, testi fejlődésben megmutatkozó variációkat a különböző populációkban (TANNER és EVELETH, NIANG). Végül két tanulmány a problémakör szociológiai, kulturális aspektusait elemzi (COMER, MCANARNEY).

A tanulmánykötet tehát sok témát, sok oldalról világít meg, sokszor nagyon is részletesen. A konferencián elhangzott viták — amelyeket ugyancsak olvashatunk az egyes tanulmányok után — érzékeltetik, hogy a résztvevők előtt maradtak nyitott kérdések. Nem lehet persze figyelmen kívül hagyni azt a tényt (amiről ebben a megfogalmazásban nem szól ugyan a könyv), hogy a pszichológiai vizsgálatok mennyire időigényesek. Ezért nehézkes úgy megszervezni a kutatást, hogy a relatíve gyorsan lebonyolítható, természettudományos igényű, adekvát orvosi—humánbiológiai methodikákkal párhuzamosan a pszichológiai vizsgálatok is hasonló igényességgel történjenek. Ez részben magyarázza (ha nem is menti!) a sok, kevésbé igényes pszichológiai vizsgálatot, amelyekről beszámoló cikkek elárasztják a szaksajtót. Lehet, hogy még hosszú ideig be kell érnünk egy laza párhuzamossággal a biológiai és pszichológiai vizsgálatokban? E könyvben is ezt látjuk: a különböző szakterületek sokszor valóban kiemelkedő képviselői a saját szűkebb vizsgálataikról számolnak be, igazán komplex kutatásokról alig. Ha azonban nem is olvashatunk egy összefoglaló értékelést, számos részletkérdésről kaphatunk átfogó, legtöbbször didaktikusan bemutatott képet. Ezért hasznos e kötet a növekedés, testfejlődés, érés kérdéseivel foglalkozó szakembereknek.

Dr. Eiben Ottó

4.768

TARTALOM — CONTENTS

Eredeti közlemények — Original investigations

A kiadásért felelős az Akadémiai Kiadó igazgatója
Műszaki szerkesztő: Marton Andor
A kézirat nyomdába érkezett: 1981. január 9. — Terjedelem: 26,6 (A/5) ív
81.9136 Akadémiai Nyomda, Budapest — Felelős vezető: Bernát György

PSZICHOLÓGIA

Az MTA Pszichológiai Intézetének gondozásában megjelenő

új folyóirat

A tudományág második magyar nyelvű szakmai fóruma

A folyóiratban olvashatók:

— beszámolók eredeti alapkutatásokról
— elemzések a pszichológia átfogó kérdéseiről
— beszámolók interdiszciplináris kutatásokról
— elemző szemlék a pszichológia egyes területeinek legfrissebb eredményeiről
— kritikai reflexiók, recenziók

Az 1981-es évfolyam tartalmából:

KARDOS LAJOS: Az emlékezés két funkciója
RANSCHBURG JENŐ: A nemi identitás fejlődése
MARTON LAJOSNÉ: Az állandó tér észlelése
ENGLÄNDER TIBOR, FARKAS ÉVA: Bizonytalanság és mágikus paraméterek
BUDA BÉLA: A tudattalan szemantikai elmélete
MÉREI FERENC és munkatársai: A pszichodráma játék formalizálása
PLÉH CSABA: Mondatértelmezés kisgyermekkorban

Az első szám 1981-ben jelenik meg

Terjeszti a Magyar Posta

Előfizethető bármely postahivatalban, a kézbesítőknél és a Posta Központi Hírlapirodánál (KHI, Budapest V., József nádor tér 1. 1900) közvetlenül vagy postai utalványon, valamint átutalással a KHI-215-96162 pénzforgalmi jelzőszámra.

Index-szám: 25.709

Folytatás a borító 2. oldaláról

7. A tanulmányok statisztikai feldolgozásánál alkalmazott matematikai képletek jelöléseinek pontos magyarázatát meg kell adnia a szerzőnek. Ugyanez vonatkozik görög betűs vagy egyéb speciális jelölésekre is. Általában a *Biometriai Értelmező Szótár* (Szerk.: Jánosy A. — Muraközy T. — Aradszky G. — Mezőgazdasági Kiadó, Budapest, 1966.) előírásait, jelöléseit célszerű követni.

8. A tanulmányok tagolásában az alábbi beosztási elvek követését tartjuk kívánatosnak: 1. Bevezetés (a probléma felvetése, mai állása). 2. Anyag és módszer. 3. A vizsgálat, kutatás eredményei és azok (összehasonlító) értékelése. 4. Összefoglalás.

9. A tanulmány, közlemény végén irodalomjegyzéket kell megadni, de csak azok a művek idézhetők, amelyeknek adatait vagy megállapításait a szerző tanulmányában valóban felhasználta. Az irodalomjegyzéket a szerzők nevének „abc" sorrendjében kell összeállítani. A szövegben a szerző neve után (zárójelbe) tett évszámmal utalunk a megfelelő irodalomra.

A folyóiratok címeinek rövidítésére a szakirodalomban kialakult és elfogadott rövidítéseket alkalmazunk.

Az irodalomjegyzék összeállításához az alábbi példák szolgálnak útmutatásul:

Folyóiratcikkeknél a szerző(k) vezetékneve, rövidített utóneve, a megjelenési év zárójelben, kettőspont, a közlemény címe, a folyóirat hivatalos rövidítése, a kötetszám arab számmal, aláhúzva, pontosvessző, oldalszám, pl.:

Bartucz, L. (1961): Die internationale Bedeutung der ungarischen Anthropologie. Anthrop. Közl. 5; 5—18.

Könyveknél a szerző(k) neve, a kiadási év zárójelben, kettőspont, a könyv címe, a kiadó neve, a kiadás helye, pl.:

Bartucz, L. (1966): A praehistorikus trepanáció és orvostörténeti vonatkozású sírleletek (Palaeopathologia III. kötet). Országos Orvostörténeti Könyvtár és Medicina Kiadó, Budapest.

Másodidézeteknél — ha azok el nem kerülhetők — az idézett szerző neve után *cit.* szócskát írunk, és a fenti módon idézzük a könyvet vagy a folyóiratcikket, ill. *in* szócskát írunk, ha tanulmánykötetben megjelent cikket idézünk.

Ha egy szerzőnek ugyanabból az évből több tanulmányát idézzük, akkor az évszám mellé írt *a*, *b*, *c* betűkkel különböztetjük meg őket.

10. A szerzők a nyomdai tipografizálásra vonatkozó kívánságaikat a kézirat másodpéldányán jelölhetik be ceruzával, a nyomdai előírásoknak megfelelően.

Kérjük szerzőinket, hogy a fenti alaki előírásokat — a tanulmányok gyorsabb megjelenése érdekében is — tartsák meg. Az előírásoktól eltérő kéziratokat a Szerkesztő bizottság nem fogad el.

A kéziratokat a szerkesztő címére kell beküldeni, aki a tanulmány beérkezését visszaigazolja. A közlésről — a lektori vélemények alapján — a Szerkesztő bizottság dönt. Erről értesítik a szerzőt.

A közlésre kerülő dolgozatok korrektúráját az ábralevonatokkal együtt megküldjük a szerzőknek. A javított korrektúrát az esetenként megadott határidőig kérjük vissza. A megadott időpontig vissza nem juttatott dolgozatot kénytelenek vagyunk kihagyni a készülő számból.

A szerzőknek a kiadó tiszteletdíjat és 100 db különlenyomatot ad.

A *Szerkesztő bizottság* tagjai: Dr. Eiben Ottó (szerkesztő), Dr. Éry Kinga, Dr. Farkas Gyula, Dr. Lipták Pál, Dr. Nemeskéri János, Dr. Schuler Dezső és Dr. Tóth Tibor.

A szerkesztő címe: Dr. Eiben Ottó, 1088 Budapest, Puskin u. 3. ELTE Embertani Tanszéke.

A kiadvány előfizethető és példányonként megvásárolható:

az AKADÉMIAI KIADÓNÁL: 1363 Budapest V., Alkotmány u. 21., telefon: 111—010. Pénzforgalmi jelzőszám: 215—11488.

az AKADÉMIAI KÖNYVESBOLTBAN: 1368 Budapest V., Váci u. 22., telefon: 185—680.

Előfizetési díj egy évre: 52,— Ft

Külföldön terjeszti a KULTÚRA Külkereskedelmi Vállalat 1389 Budapest I., Fő u. 32. Pénzforgalmi jelzőszám: 218—10990., telefon: 159—450.

JÓZSEF MEGYEI KÖNYVTÁR ... KECSKEMÉT

Ára: 52 **Ft**

Előfizetési ára egy évre: 52 **Ft**

INDEX: 26.028
ISSN 0003–5440

Tartalomjegyzék a 301—302. oldalon!