ANTHROPOLOGIAI KÖZLEMÉNYEK

A MAGYAR BIOLÓGIAI TÁRSASÁG
EMBERTANI SZAKOSZTÁLYÁNAK FOLYÓIRATA

Szerkesztő:
EIBEN OTTÓ

33. kötet 1–2. füzet

BUDAPEST
1991

ANTHROPOLOGIAI KÖZLEMÉNYEK

(Founded by M. MALÁN)

Editors: M. MALÁN (1954–1967), J. NEMESKÉRI (1968–1976)

A periodical of the Anthropological Section of the Hungarian Biological Society

Felhívás a szerzőkhöz

Az Anthropologiai Közlemények a Magyar Biológiai Társaság Embertani Szakosztályának folyóirata, a Magyar Tudományos Akadémia Biológiai Tudományok Osztályának felügyeletével és erkölcsi támogatásával jelenik meg. Szerkeszti a szerkesztőbizottság.

A szerkesztőbizottság elfogad a fizikai antropológia, ill. az általános (nem klinikai) humángenetika témaköréből önálló vizsgálatokon alapuló tanulmányokat, továbbá olyan kritikai vagy szintézist tartalmazó közleményeket, amelyek az embertani tudomány előbbrevitelét szolgálják. A közlés alapfeltétele általában az, hogy a tanulmányt a szerző a MBT Embertani Szakosztályának szakülésén előadja.

Az előadásokat a szakosztály titkáránál lehet bejelenteni és azok műsorra tűzéséről a Szakosztály intézőbizottsága dönt.

Az Anthropologiai Közleményekhez közlésre benyújtott kéziratok tartalmi és formai követelményei a következők:

1. A tanulmányok világosan fogalmazott célkitűzésű, korszerű módszerekkel végzett vizsgálatok igazolt, bizonyított eredményeit tartalmazzák, tömör és érthető stílusban. A tanulmányok terjedelme mondanivalójuk mértékéhez igazodjon. A rendelkezésre álló évi 12 ív terjedelem korlátozza az egyes tanulmányok terjedelmét, ezért 2–2,5 szerzői ívet meghaladó terjedelmű kéziratokat nem áll módunkban elfogadni. A történeti antropológiai tanulmányoknál egyedi méreteket – őskori és honfoglalás kori szériák kivételével – általában nem közlünk.

2. A kéziratot A/4 alakú fehér papírra, kettős sorközzel, a papírlapnak csak az egyik oldalára kell gépelni, oldalanként 25 sor, soronként 55–60 betűhely lehet. Minden dolgozatot két teljes, nyomdakész kéziratpéldányban kell benyújtani, összefoglalással, táblázatokkal, ábrákkal együtt.

3. Az idegen nyelvű összefoglalást – amely a tanulmány terjedelmének mintegy 10 százaléka – az Anthropologiai Közlemények a kongresszusi nyelvek egyikén közli. Az idegen nyelvű összefoglalásnak tartalmaznia kell a probléma felvetését, az alkalmazott vizsgálati módszert, valamint a kutatás legfontosabb eredményeit.

A tanulmány címoldalán 150 szónál nem nagyobb terjedelmű, angol nyelvű *Abstract*-ot közlünk. A fordításról – ha a szerzőnek nem áll módjában – a szerkesztő gondoskodik.

4. A tanulmányhoz tartozó táblázatoknak, ábráknak az Anthropologiai Közleményeknél az utóbbi évfolyamokban kialakult egységes gyakorlatot kell követniük.

A táblázatokat a tudományos dokumentáció elveinek figyelembevételével kell megszerkeszteni. Az egyes tanulmányokhoz tartozó azonos típusú táblázatoknak egységeseknek kell lenniük. A folyóirat tükrébe be nem férő táblázatok több részre osztandók; több oldalas (behajtós) táblázatokat nyomdatechnikai okokból nem fogadunk el. Minden táblázatot külön lapra kell gépelni, sorszámmal és címmel kell ellátni.

5. Csak gondos kivitelű és klisézésre alkalmas minőségű ábrákat fogadunk el. A rajzon alkalmazott jelölések világosak, egyértelműek legyenek. Minden ábrát, függetlenül attól, hogy vonalas rajz vagy fotó, *ábra* jelöléssel, sorszámmal és aláírással kell ellátni. A műnyomó papírt igénylő fényképeket tábla formájában közli a lap; ezek összeállításánál a szerzőknek a tartalmi követelmények mellett az esztétikai szempontokat is figyelembe kell venniük.

Folytatás a borító 3. oldalán

The Anthropologiai Közlemények is indexed in Current Contents.

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The bronze plaquette of the Congress made by Mr. Sándor Kiss, sculptor

E kötet megjelenését a Művelődési és Közoktatási Minisztérium Könyv-, Lap- és Irodalmi Főosztályának jelentős anyagi támogatása tette lehetővé.

ITC PLANTIN KFT.–910209

Anthrop. Közl. *33;* 3–4. (1991)

REFLECTIONS ON THE QUESTION: "YOUTH AT THE END OF THE 2OTH CENTURY"

Opening Address at the Fifth International Symposium of Human Biology Keszthely, 3–6 June, 1991

O.G. Eiben

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It is my great pleasure and honourable task to have the occasion for the fifth time to welcome all of you to our Symposium. The series of our Symposiums of Human Biology have already become a nice tradition, and without any immodesty we can state that our preceding symposiums were successful.

In 1976, in Balatonfüred, in connection with the "summing up" phase of the International Biological Programme, the main subjects of our First Symposium of Human Biology were ***Growth and Development*** *of children as well as the variations of human* ***Physique,*** *themes which had been in the centre of interest long ago. Our intention at that time was to open the Hungarian physical anthropology's/human biology's windows wide at the world.*

In 1979, in Visegrád, the main subject of our Second Symposium was the ***Functional Biotypology,*** *and the overwhelming majority of presentations dealt with different aspects of the human physique. However, several lectures touched on the problems of growth and development of children, and so, we intended to contribute to the success of the International Children's Year.*

In 1981, in Bozsok, during our Third Symposium, we discussed the ***Variations of Human Growth and Physique,*** *especially four aspects of them: the genetical, the clinical, the ecological, and the kinanthropometrical sides of this problem-circle.*

In 1986, in Pécs, as main topic of our Fourth Symposium we have chosen the ***Growth Standards,*** *again a theme which was in the forefront of interest of human biologists as well as pediatricians decades ago.*

The multidisciplinary character of our symposiums was ensured.

What are the causes, of this great interest?

Simply two facts, I think. Firstly, a lot of us have a feeling of responsibility for the children's welfare, and secondly, growth and development data constitute a comprehensive and sensitive indicator specific to child health.

In 1991, here in Keszthely, we should like to discuss the problem ***of youth at the end of the 20th century.*** *I do not think that the importance of this problem can be overstated.*

In 1991 we remember some of the great personalities of universal cultural history. I mention here two names: Wolfgang Amadeus Mozart, and the Hungarian Count István Széchenyi.

The whole of mankind remembers W. A. Mozart who died 200 years ago. What does he say to the people of our age full of strain and worries? In one of Platon's dialogues, "The Junket" (in Greek: Symposium) the characters vary the theme of eros and love. This opus in one of the most excellent variation-works in world literature. One of its characters, the sophist, says that ***eros*** *is an ability of man that he/she should have some inclination towards other men, great ideas, and important things. This is such a great adviser which accompanies one in any fields and situations of life. Mozart is such an accompanist for our lives. He is an amiable companion who keeps alive our confidence reposed in mankind. Mozart's music is our travelling companion from the cradle throughout childhood, adolescence and the whole of life, and it can give some protection against many troubles and hurts.*

We all need such a protection, and children especially need such protection. This perception guided us as we founded the Hungarian Forum of Interest of Children, and have chosen the slogan: "With deciduous teeth to stone. . ." We had the feeling that children – generally – are in a defenceless situation.

Dr Árpád Göncz, the President of the Republic of Hungary also establish the fact that during the last one and half years the conditions of the Hungarian youth became worse. I will not go into the details of this problem, however, I call your kind attention to the problem of equal chances.

This is not only a question of right; it is also a general problem of human biology. Allow me, please, to cite some results from our Hungarian National Growth Study (Eiben 1989, Eiben – Pantó 1986, 1987/88, etc.).

The urban environment in Hungary provides more advantageous conditions for children's growth and development than the rural one. Hence urban children grow faster and mature earlier than their rural counterparts.

The educational level of the fathers and mothers the growth and maturation process of their children. The higher the father's educational level the taller are their sons. In this group also the pubertal growth spurt occurs earlier than in other groups of boys. According to the educational level of the mothers, boys show a similar picture, and indeed, in sons of mothers with low educational level, backwardness in growth and development is more evident. This phenomenon is further expressed in girls, especially after puberty, particularily in daughters of fathers and mothers with low educational level who are the shortest, and in daughters of fathers and mothers with university degree who are the tallest. For Hungarian youth the educational level of the parents is a determinant. So, the higher the educational level of the parents the taller are their sons and daughters. These differences in height usually can be observed already in early childhood, and during prepuberty and puberty they usually become more marked. These differences between the two extrem social groups (6–7 cm) are significant in both sexes.

Profession of parents also influences the growth and development process of the children characteristically. The trend of tallness goes from agricultural manual workers through industrial and other manual workers to non-manual workers. However, profession of parents as an organizing principle – at least in present-day Hungary – is less suitable to describe the family's standard of living, or to characterize the child-centredness of the family home. The most important environmental factor seems to be the educational level. We are convinced that the cultural niveau is the most important social factor influencing growth and maturation of youth. Consequently, it seems important to point out the role of the parents, principally the determinative role of the mothers, in creating a better cultural background in the family (Eiben 1989).

To be able to do that, one must be well educated.

And now, in this sense, I return to Count István Széchenyi, to "The Greatest Hungarian", born 200 years ago. He was the builder of the Chain-bridge between Pest and Buda, the establisher of steamshiping on the Lake Balaton, the organizer of horse-racing in Hungary, the regulator of the Lower reaches of the Danube, etc., etc., and last but not least, he was the founder of our Hungarian Academy of Sciences. One of his great and leading principles was: "The quantity of the well-educated heads is the real power of the nation." (You can see his figure and this sentence in Hungarian in your Programme and Abstract booklet, on its second page.)

Here and now, during this special peeriod of change in Hungary, we need to follow this principle. We human biologists work on several problems of youth, we work for the youth, as Count Széchenyi recommended: In one's own sphere of influence everybody according to his/her best of knowledge...

I am convinced that we work for a good cause, and that even here at our Symposium the presentations given will make useful contributions to the ambition of "Health for all by 2000!" and for our youth at the end of the 20th century.

In this spirit I wish for a successful Symposium!

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Anthrop. Közl. 33; 5–16. (1991)

CAUSES WHICH LIMIT THE GROWTH OF THE ANIMAL BODY

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Abstract: *My title is a translation of that of the very first scientific study of human growth* (Causas incrementum corporis animalis limitantes) *which was made by Christian Friedrich Jampert in 1754 on children of the Berlin Royal Orphanage. I examine the question: in what sense do we know more now about factors responsible for the variation in height in a population than did Jampert. I discuss growth regulation and catch-up; the growth curves of tall and short adults; the mechanism of the growth plate; and the reasons why variation in growth hormone level are not responsible for adult height variation. More likely candidates are variation in the amount of IGFI secreted by the proliferative cells of the growth plate, variation in the IGFI receptors, or variation in the control of the number of divisions the cells make before exiting the cell cycle.*

Key words: *Christian Friedrich Jampert; Genetic–environment interaction; Catch-up growth; Growth plate; Growth hormone.*

Introduction

The title of my paper "The causes which limit (or perhaps better, control) the growth of the animal body" is a quotation from the 18th century. It is the title of the doctoral thesis ("Causas incrementum corporis animalis limitantes") in which appeared the very first study of human growth, a study made in the Spring of 1754 by Christian Friedrich Jampert on children of the Berlin Royal Orphanage. It was defended on October 5th 1754 in the medical school of Halle, a small town a little to the north of Leipzig, which at that time was one of the great centres of European scholarship and particularly medicine. I chose the title first because it describes exactly the subject I am going to discuss and second because Jampert is something of a favourite of mine. Chiefly, this is because he was the first person ever to publish measurements of children at successive ages (he measured just one boy and one girl at each year of age, choosing each time one he thought typical of the age group). But also, I confess, it is because I myself resurrected him from a totally undeserved oblivion. He had a brilliant but hopelessly short career, dying, probably of tuberculosis, just four years after he graduated. He emerged, like Lazarus, when I was turning over the gravestones of the British Museum Library in the late 1970's. All the other 18th century theses on growth were boring, repetitive, barbarously written and lacking any observational data whatever. Jampert's, in total contrast, was alive, modernly scientific in outlook and analysis, and written with elegance and understanding (Tanner, 1981; Tanner, 1989a).

Jampert's view of what limited the growth of the animal body was iatro-physical, in the new scientific-mechanical tradition of the Italians Borelli and Bellini – derived from Galileo – in which the hydraulics of body fluids were given a prominent place in physiology and medicine. Growth results from the pressure of the fluids in the blood vessels being greater than the resistance of the fibres of the body, especially those of the bones. The body therefore stretches and this ceases when the ever-increasing resistance finally equals the fluid pressure. Girls grow up earlier than boys because their fibres have less resistance, so stretch more easily. At least this is true of girls in comfortable circumstances. Working girls, whose fibres are toughened by their toil, grow up scarcely any earlier than boys, and rarely menstruate before 17 or even 20 years of age.

The question I should therefore like to address is: can we do any better than Jampert at explaining the causes that limit growth? How do we see the problem nowadays? It is convenient to start by distinguishing what Aristotle would have called 'final' and 'efficient' causes; in other words, results themselves and the mechanisms by which they are achieved. First then, the phenomenology of the regulation of growth; later, a discussion of how the regulation is effected.

Phenomenology: Genetic–environment interaction and catch-up growth

It is a truism that the ultimate stature attained by any individual is the result of the continuous interaction, throughout the whole growth process, between forces set in motion by the genes and the effects of the environment. The interaction is not necessarily additive, nor constant from age to age. There are some periods of growth more sensitive than others to environmental deprivation, and there are some individuals who are more able to resist a bad environment than others, so that two children who might have grown up to be identical in height in an optimal environment may well have different heights in a suboptimal one.

But the childhood organism has an astonishing capacity for recovery from environmental set-backs unless they are severe and prolonged. In the individual the process is known as catch-up growth (Prader, Tanner and von Harnack, 1963) because the child whose growth has been slowed by malnutrition perhaps, or a hormone deficiency, resumes growth at a greater-than-normal velocity when food or the hormone is supplied again and thus catches up in height to or at least towards the height he would have been in the absence of the growth restriction. In other words, he seeks to regain his pre-programmed growth curve. When he gets to it, he throttles down, and goes along it once again as though nothing had happened. *Figure 1* shows an example of the process.

A particularly interesting example of catch-up demonstrated by a whole population occurred in Holland during the last stages of World War II. Between October 1944 and May 1945, there was a severe famine in the central part of Holland, including in Rotterdam. In the cohort of children exposed to the famine during their last three months *in utero*, birthweight diminished by 9% and birth length by 2.5%. At age 19 the males of this cohort entered military service; their heights and weights by that time were no different from those of their contemporaries who had not been undernourished (Stein et al. 1989). Even from such an extensive and such an early deficit, catch-up can be complete provided the undernutrition does not last too long and provided that conditions are genuinely good during the rest of childhood.

Our current picture of the environmentally-caused stunting that occurs in a large proportion of the population of the Third World is as follows. Birthweight is often little below that of the developed countries, and length and weight growth is normal during the first six to nine months after birth. Thereafter recurrent infections interact with a nutritional intake already at borderline level. During an episode of infection, nutritional intake falls, and growth slows down or stops. When the infective episode finishes, catch-

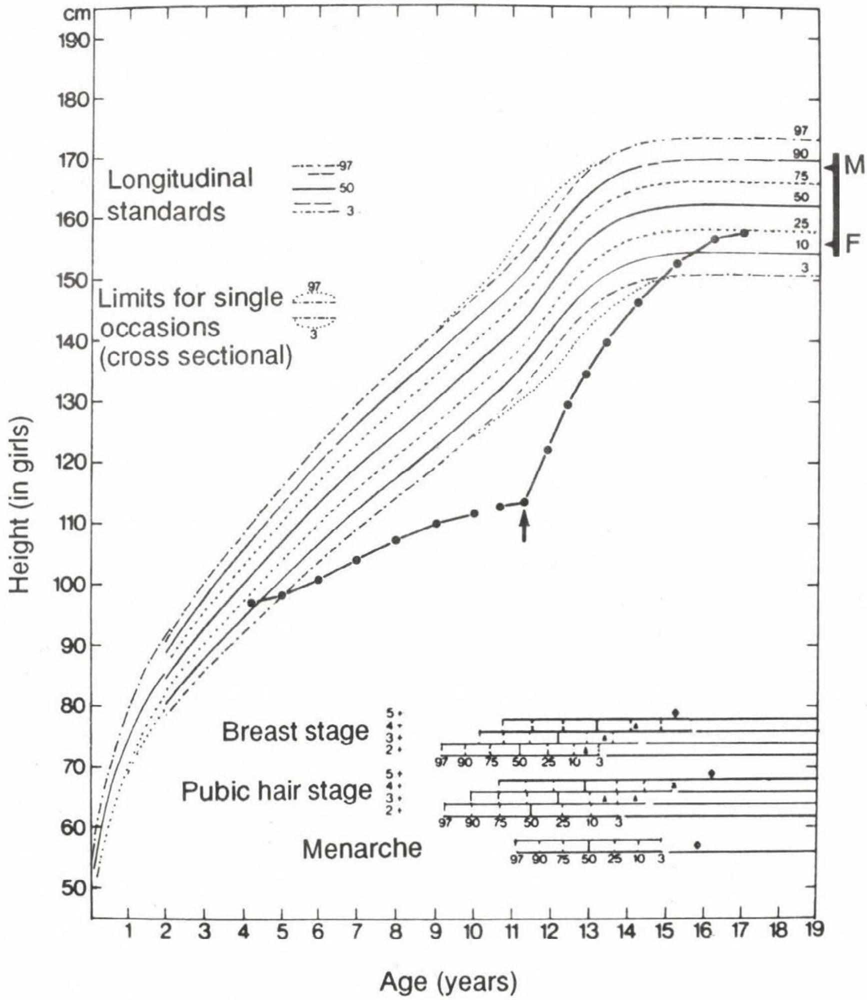

Fig. 1: **Growth in height of a girl with coeliac syndrome to show catch-up on commencement of diet (marked by an arrow). From Tanner (unpublished)**

-up growth restores the situation to normal in a child easily provided with the extra calories necessary to fuel it. But the amount of calories is considerable, and in the Third World these are often unavailable. Thus repeated infections, particularly during the age period of nine months to about five years, result in a lower adult height than the genes had planned for. Precisely the same mechanism seems to be at work in generating the (much smaller) differences seen between social classes in most countries of the industrialised world. Here also most of the adult differences, typically around 3 cm between non-manual and unskilled manual classes, are established in the age period nine months to three years (see Tanner, 1989b, pp 133; 149).

So much, albeit briefly, for the environmental effects limiting adult height. We now turn to the *genetic* ones, supposing we have a population all growing up in comfortable, middleclass circumstances, with loving, intelligent – even Green – parents. In passing we have to remember that the mechanisms controlling catch-up in the *individual* may be quite different from the mechanisms controlling variation *between* individuals growing up in circumstances where catch-up is unnecessary. The standard deviation of adult height in such a well-circumstanced population is about 6.5 cm in men and 6.0 cm in women. The range of heights which includes 95% of such men is thus about 26 cm. But the range of heights amongst brothers is a great deal less than this; in fact about 16 cm. And the range amongst monozygotic twins, in these circumstances, is only 1.6 cm, of which at least half must represent the inevitable measuring error (see Eveleth and Tanner, 1990).

Table 1. **Mean difference between lengths of monozygotic twin pairs (140 pairs) and same-sex dizygotic twin pairs (90 pairs) from birth to 4 years, and within-pair correlation coefficients [From Wilson (1979), cited in Tanner (1989b)]**

Age	Mean difference in length (cm)		Correlation coefficient	
	MZ pairs	DZ pairs	MZ pairs	DZ pairs
Birth	1.8	1.6	0.58	0.82
3 months	1.4	1.6	0.75	0.72
6 months	1.3	1.9	0.78	0.65
1 year	1.3	1.8	0.85	0.69
2 years	1.1	2.4	0.89	0.58
3 years	1.1	2.9	0.92	0.55
4 years	1.1	3.2	0.94	0.60

This genetic control is a highly active regulatory force. Monozygotic twins have to work at reaching the same ultimate height; they do not start out that way. *Table 1* (from Wilson, 1979, cited in Tanner, 1989) shows the well-known values from Wilson's superb study of twins in Louisville, Kentucky. At birth MZ pairs showed just as much difference in lengths as DZ pairs, this because birth length depends so much on the precise position, blood supply and so forth, in the maternal uterus. By three months the MZ twins' difference had diminished from 1.8 cm to an average of 1.4 cm; and by two years it was down to 1.1 cm where it stayed till four years. DZ pairs, in contrast, increased their between-pair differences, from 1.6 cm at birth to 2.4 cm at two years and 3.2 cm at four years.

Thus, in summary of the phenomenology, we can say that final adult height is controlled by the genes, provided the environment is sufficiently favourable to permit them to carry out their plans. Thus the differences amongst a set of five brothers growing up in optimal circumstances measures their genetic difference. The difference between the *mean* of their heights and the *mean* of the heights of five other brothers of the same ethnic group but growing up under deprived circumstances measures the effects and the depth of the deprivation.

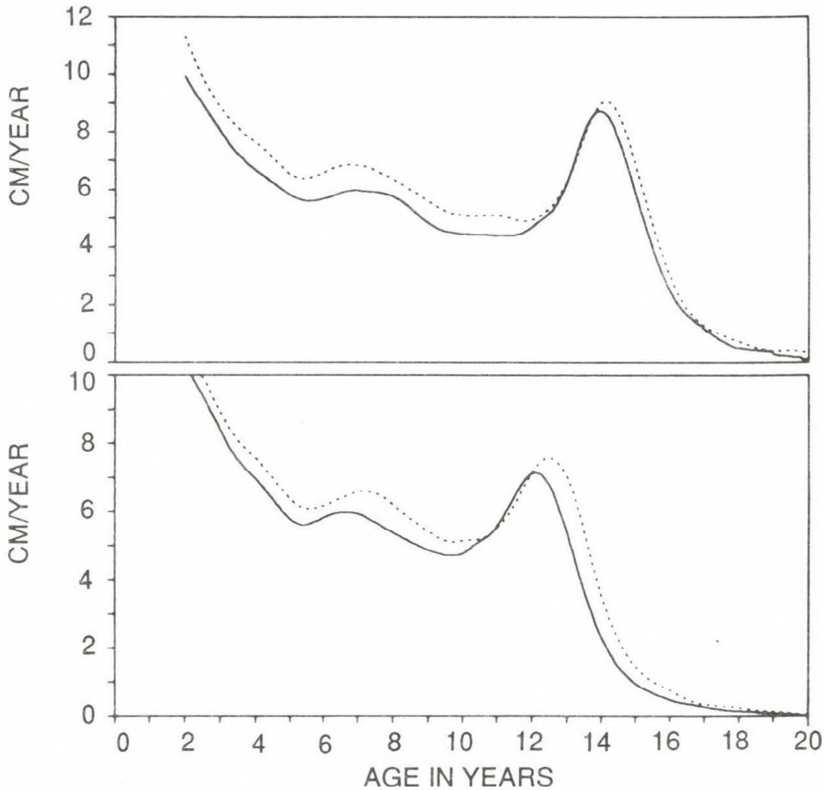

Fig. 2: Growth velocity structural average curves of tall and short children of Zurich First Longitudinal Study (from Gasser et al. 1989)

One last point of phenomenology before we pass to mechanism: At what point during growth does the difference between tall and short adults chiefly arise? Surprisingly it is only very recently that this question has been addressed by researchers working on the major longitudinal studies of growth around the world. Gasser and his associates (1989) have contrasted the growth curves of the 25% tallest (as adults) and 25% shortest boys and girls of the Zurich First Longitudinal Growth Study. They used a particularly sophisticated method to produce the "structural" average curves shown in *Figure 2*. It can be seen that most of the difference arises from the tall having a consistently greater growth velocity between the ages of two and the beginning of puberty. Before two and during puberty, the differences in the velocity curves are less.

In these data in fact, about 80% of the difference between tall and short has arisen before puberty; only about 20% is contributed by a greater pubertal spurt in the tall. Another way to look at these figures is by calculating the ratios of the heights of the short and tall at successive ages. At two years the ratio is little less than unity; at maturity it is 0.92 for both girls and boys. It thus decreases during growth. At the beginning of puberty it has already reached 0.93 in the boys and 0.92 in the girls.

Incidentally, the age at which peak height velocity is reached is about 0.3 years later in the tall, of both sexes, than in the short. This is a small difference, amounting to 0.3 SD of age at PHV, but it is a statistically significant one.

Thus when we consider mechanisms we will want in particular to concentrate on factors regulating velocity during the period from age two to the beginning of puberty.

Mechanisms: the growth plate, hormones and genes

We now discuss the mechanisms by which regulation and limitation of adult stature are effected. Let us start at the peripheral end of the chain and work gradually backwards.

Since in Man the great majority of growth occurs postnatally and we are in any case concentrating on the period of prepubertal childhood it is the physiology of the epiphyseal growth plates that is our prime interest. In the typical plate there is next to the epiphysis a layer of stem cells (very narrow in most mammals, but surprisingly wide in Primates, for reasons unknown). Above this is the proliferative chondrocyte zone, then the zone of hypertrophied chondrocytes, ending at the point where the cartilage plate gives way to the metaphyseal bone (*Fig. 3*). Seen from above the growth plate is a relatively thin, disc-like structure, a sort of washer between epiphysis and metaphysis.

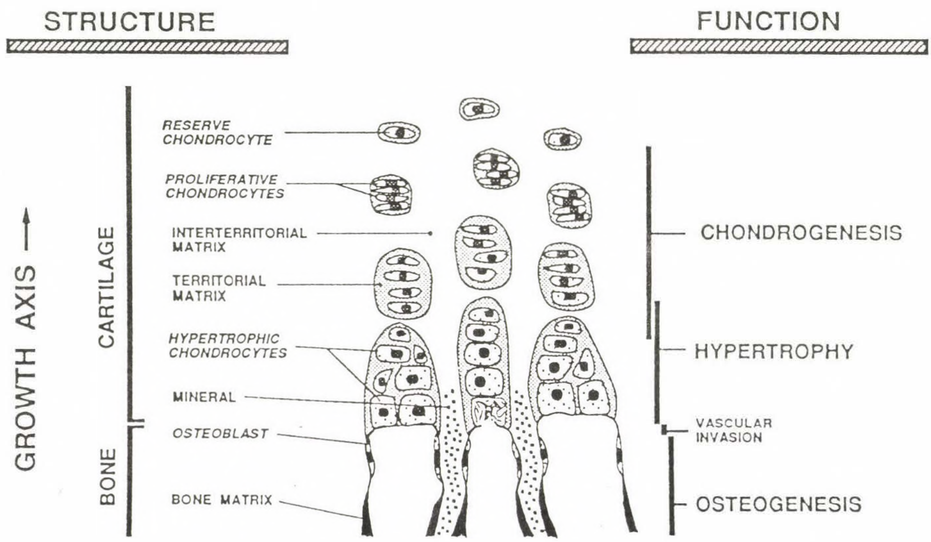

Fig. 3: Diagram of growth plate: Structure–function relationships (from Horton, personal communication)

Seen from the side, it consists of several thousand axial columns, each separated from the others by longitudinal septa, which constitute the intercolumnar matrix. At the bottom of each column lies a single stem cell, or prechondrocyte, which is the origin of all the cells making up that particular column. Stem cells have a low frequency of division; proliferative cells divide more frequently, but exhaust their mitotic ability after six to eight divisions. They then turn into the massive hypertrophic cells, which continue to secrete a succession of substances, finally dying and being removed by the encroaching metaphyseal bone front. In the distal femoral epiphysis, the only extensively studied growth plate in Man, there are about 35 proliferative and seven hypertrophic cells in a column at any given moment during the childhood years (Kember and Sissons, 1976). All of these cells constitute a clone of the original stem cell. Eventually all the members of the clone terminate their life cycles by being engulfed by the advancing metaphyseal bone, but meanwhile a stem cell neighbour has divided and given rise to a new clone, opening up a nearby parallel channel (or even perhaps using the same channel). Kember and Sissons estimated that to grow a rat's tibia would require some 40 or so stem cell divisions, that is 40 successive clones. Calculations indicate that the clone size in the human femoral growth plate totals around 200 cells (compared to the rat's 60) a figure which implies that a large number of stem cell divisions must also occur during human growth.

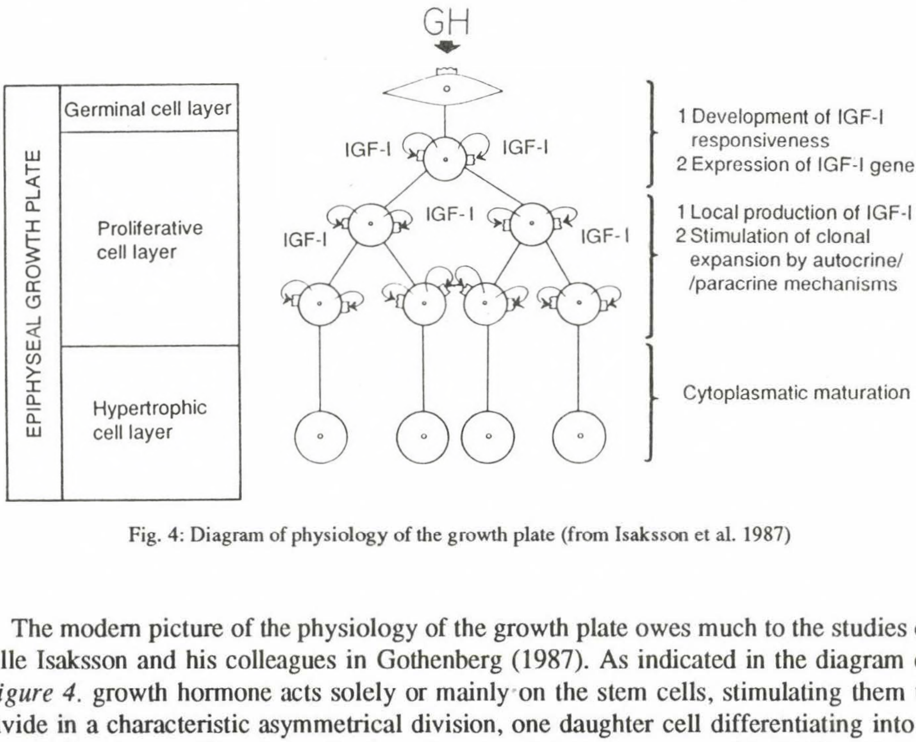

Fig. 4: Diagram of physiology of the growth plate (from Isaksson et al. 1987)

The modern picture of the physiology of the growth plate owes much to the studies of Olle Isaksson and his colleagues in Gothenberg (1987). As indicated in the diagram of *Figure 4.* growth hormone acts solely or mainly on the stem cells, stimulating them to divide in a characteristic asymmetrical division, one daughter cell differentiating into a first generation proliferative cell, the other remaining as a stem cell. Differentiation involves a change of phenotype, with the appearance of a range of structural proteins, and an activation of the genes expressing a number of factors, amongst which is the all-important IGF I and also its membrane receptor (the little square in the Figure). IGF I, a 70-amino acid peptide, stimulates division of the proliferative cells by autocrine and paracrine actions. After some six to eight divisions (on average) the proliferative cells run out of the capacity to divide further, or, as the cell biologists put it, are withdrawn from the mitotic cycle. The molecular biology of this all-important event is not understood.

Growth hormone is therefore an important control for longterm post-natal growth, causing replacing of the clones every few months in the human (and every week or so in the rat). (Children totally lacking growth hormone due to a gene deletion do grow but end some 6 SDs below normal: as usual therefore it seems that the growth hormone acts as catalyst to speed up a process which, in a small way, takes place without it.) IGF I controls shorter-term growth. The whole process is very highly regulated, so that production of chondrocytes at one end of the column and destruction at the other remain in a fine-tuned balance. The regulation almost certainly involves feed-back from the cartilage matrix to the cell columns, and it is likely that small molecules diffuse down from the metaphyseal bone front into the hypertrophic layer, the end-point of their diffusion perhaps being one of the factors marking the proliferative-hypertrophic border.

Turning to the *rate of growth:* the total amount of growth achieved in a given time by a growth plate column depends first on the number of new proliferative cells added in that time (each one contributing some 9 microns); secondly, on the increase in height of each chondrocyte when it changes from proliferative to hypertrophic (about 24 microns added) and thirdly on the amount of matrix synthesised and lodged within the structure of the column (mainly between the cells of the hypertrophic zone). The first factor, the number of proliferatives added, itself depends on two things: the number in the column open to division, and the average frequency with which they divide, the so-called cell cycle time.

The cell cycle time has been worked out only for one growth plate in Man, that of the *distal femoral epiphysis*. In the early days of the Harpenden Growth Study (Tanner, 1962) lateral radiographs of the knee were taken at six monthly intervals and in about a quarter of the plates we could see the transverse lines of growth known as Harris' lines. These persist for several years and hence can be used as markers in exactly the same way as layers of injected tetracycline are used in experimental animals. Thus the growth rate at the epiphysis can be calculated, and since the size of the hypertrophic cell is known, the number of hypertrophics eliminated per unit of time is calculable. It turns out that the cell cycle time in this human growth plate during mid-childhood is around 20 days, which contrasts with the cell cycle time in the rat tibial epiphysis which is 2.5 days.

Age Factors

It seems that the diminution of rate of growth which occurs as the child or young animal gets older is due to a progressive decrease of cell production in the proliferative layer. In the rat tibial epiphysis for example, the rate falls from about 11 cells/day at its maximum to 8 cells/day at 40 days and 4 cells/day at 80 days (Hunziker and Schenk, 1989; Thorngren and Hansson, 1973). The cell cycle time remains unchanged, so an increasing proportion of cells seems to be withdrawn from the cycle. Since it is local IGF I which stimulates cell division this may imply that local IGF I levels diminish with

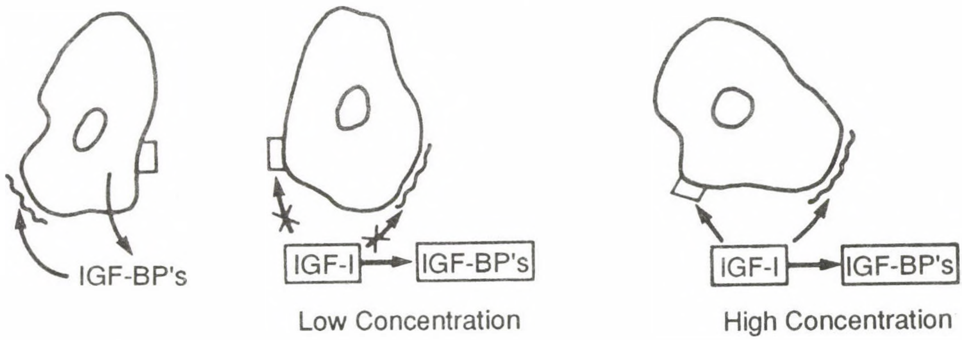

Fig. 5: Illustration of action of IGF I binding proteins (from Clemmons, 1990)

age. Alternatively the amount of IGF I receptors on the cells may decrease as the cells get "older" either in a chronological sense, or in the sense of being products of an increasing number of cell divisions. A third possibility concerns the recently recognised interaction with IGF I binding proteins. There are several such in the extracellular fluid matrix surrounding the cartilage cell, and at low concentrations of IGF I they sop up, as it were, most of the IGF I secreted so that none is left to couple with the cell receptor. At higher concentrations, when these BPs are relatively saturated, IGF associates with its receptor (the rectangle in *Figure 5*) and another class of binding proteins, this time associated with the cell surface (the wavy lines). Thus alterations in the tissue matrix along the growth column, long suspected to exist on other grounds, could so regulate things that at the bottom of the column much IGF I went to the receptor, but further up less and less. Similarly, as the animal aged the binding power of the matrix may increase, so diminishing the production rate of proliferative cells. This represents the limit of our knowledge at present, but the field is a very active one (see Clemmons, 1990; Sara and Hall, 1990).

Morphological Factors

The differences between rates of growth at different epiphyses, in contrast, depend on the total number of proliferative cells in the columns of the growth plate. Thus a species with long arms and short legs would have longer proliferative zones in the arms than an oppositely proportioned species. Longer zones imply greater cell proliferation for the same cycle time, simply because of the number of cells available. What controls the length of the zones is unclear, but it must be a local property of the clones. Thus as overall growth velocity slows due to a general withdrawal of cells from the mitotic cycle, body proportions are maintained, the percent of cells withdrawn being in general the same at each growth plate (though there are exceptions implying reversal of growth gradients, particularly at puberty, perhaps due to differential loss of stem cells rather than proliferatives).

Effect of Growth Hormone

So, finally, what is it that determines the slightly higher childhood velocity which distinguishes the tall from the short? The amount of growth hormone secreted is a possible candidate, and there are some paediatric endocrinologists who indeed believe this is the mechanism. Their evidence, however, is for the most part derived from single 24-hour GH profiles on very small, i.e. less-than-2 SD-for-height children contrasted with very tall, more-than-2SD-for-height, and it is hazardous to intrapolate the same mechanisms to explain the variability seen amongst the more usual members of the population.

It is certainly true that administering extra growth hormone to children who are "small small" (i.e. less-than-2SD), *probably* including those who are so for perfectly respectable genetic reasons, does result in a small increase of height velocity for at least three or four years – perhaps more, we do not yet know – and the increase is of the general order of the difference shown between tall and short in *Figure 2*. Whether this treatment results in an ultimate height gain – of any sort, let alone the 16 cm differentiating tall and short – is questionable. We have to note, too, that other paediatric endocrinologists attribute differences in *tempo* of growth to differences in secretion rates of growth hormone. Since tempo is unrelated to final height, both sets of endocrinologists cannot be right. But both could easily be wrong.

The physiological control of GH secretion is complex and depends on an interaction between somatostatin and GHRH secretion. The feedback systems fixing the levels are incompletely understood. If levels of GH were to be the basis of this mechanism, it would presumably imply a slightly greater rate of clonal replacement in the tall, a sort of pressure from the bottom upwards on the growth plate.

There is, however, a powerful argument against GH level accounting for more than a small proportion of the genetic influence on adult height. If a polygenic system for control of GH secretion were the only genetic system concerned, then when its outcome was blocked – in growth hormone deficiency due to failure of cells downstream of the genetic mechanism – both variance and mean in such a population would be drastically reduced. Furthermore the covariance with the parents' height would also tend to zero. In practice, neither of these things happens. In one of the largest series of such patients (Burns et al. 1981) the variance of height for age was virtually normal at diagnosis (i.e. before treatment) as well as at adulthood. And the correlation with midparent height was also the same as in normals both at diagnosis and finally. At diagnosis the value was 0.55 for 39 cases, of which 26 were prepubertal and of average age about 11.5 years, and 13 cases in early puberty, which would lower the correlation a little, as it does in normals. At maturity the value for the whole group was 0.72. At the most, therefore, genes controlling the secretion level of GH play only a small part amongst the perhaps numerous polygenic systems controlling adult height.

Genetic Control

Another direction in which to look for the mechanisms that control growth would be in factors which control the expression of the gene for IGF I which is located on the long arm of chromosome 12 and has five exons which transcribe alternatively to produce two mRNA's encoding two different IGF I precursor proteins. This may provide a mechanism for variation in IGF I biological activity. Then there are the factors which control the gene for the IGF I receptor, a gene located on chromosome 15.

A further suggestion concerning the greater velocity of the tall is the straightforward one that the lengths of their proliferative zones are just a little greater than in the short. This implies that the factors fixing the line of proliferative-hypertrophic demarcation differ quantitatively. Kember (1979) has made a number of suggestions on how this line may be determined, but nothing certain is known about the mechanism. It seems to me likely that so precise a demarcation is more likely to result from a push-pull mechanism than simply a push on its own. By this I mean that an interaction of small molecules defusing downwards from the metaphysis with small molecules, perhaps IGF I itself, diffusing upwards from the proliferative layer would seem to be more stable, and more open to small genetically-controlled differences, than just the mechanism which Kember suggests, of upward diffusion only.

Of the genetic differences between tall and short that control these mechanisms, we know very little. We presume that height is controlled by a fairly large number of genes, each having a relatively small effect. Most or all of these are on the autosomes, though we do not know where. There have been suggestions that at least one fairly major gene may be located on the X chromosome (Goldman et al. 1982; Eiholzer et al. 1988) but the pattern of familial correlations is against this (Mueller, 1986), as is also the finding that the parent-offspring correlations for height remain entirely unaltered in XO Turners syndrome (Massa et al. 1990). Using the same argument as in the case of growth hormone deficiency above, this preserved correlation means that at most only a small proportion of stature-controlling genes can be on the X chromosome.

Conclusions

And so we return to Christian Friedrich Jampert and the question we set out to answer: can we do any better at explaining the causes which limit growth than his hydraulic theories of the 18th century? Well, I suppose we can; at least we can do *more*. And we can surely agree with the way he ends his thesis. Growth, he says, is not determined in an exact fashion at a given age, but varies according to circumstances. "Growth is effected," he writes in italics "by the conjunction simultaneously of many causes . . . and to enumerate all these, explain them and indicate their applications to individuals is scarcely the work of one man only, much less the theme of a modest dissertation".

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. *33;* 17–22. (1991)

END OF THE SECULAR TRENDS IN HEIGHT AND MATURATIONAL RATE OF SWEDISH YOUTH?

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Abstract: *Comparable samples of Swedish urban school children born in 1955 and 1967 were studied regarding their average heights and weights from 10–15 years. The main findings were that both boys and girls born in 1967 had been gaining more weight than height, especially around the ages at which peak height velocity generally occurs. The advantage in height of children born in 1967 gradually diminished after age at peak height velocity indicating an earlier maturation but not a taller adult height.*

In March–April 1990 a study on menarcheal age was conducted concerning a sample of Stockholm school girls born in 1971–80. For these girls mean menarcheal age by the status-quo-method was 13.19 years (SD = 1.08). Compared to that result the mean menarcheal age was 13.09 years (SD = 1.10) for a sample of Stockholm girls born in 1951–57.

From these results it was hypothezised that the secular trends in height and maturational rate of Swedish youth made a halt from the end of 1970 to about 1985; first in height and then in maturational rate.

The representativeness of the different samples as well as possible reasons for the halt of the trends were discussed.

Key words: *Secular trends; Height; Maturational rate; Menarche.*

Introduction

Secular growth changes in height, weight and maturational rate of Swedish youth have been studied regarding the period from about 1880 up to present days, showing that Swedish school children successively have become taller as well as having been maturing earlier during the last hundred years (Lindgren, 1988).

However, results from recent and current growth studies on Swedish youth indicate that these trends lately have been slowing down. Thus the purpose of the present paper is – by means of these results – to try to answer the question: Are the secular trends in height and maturational rate of Swedish youth still going on?

Materials and Methods

Results were obtained from different growth studies. Regarding average heights and weights at the ages 10–15 years samples of Swedish schoolchildren – mainly from urban areas – born in 1955 and 1967 were compared. The average growth patterns in each sample were obtained by fitting Preece Baines model 1 to the respective yearly mean values. This comparative study has been reported more in detail by Lindgren & Hauspie (1989).

In another growth study of Stockholm schoolchildren born in 1933, 1943, 1953 and 1963 average heights and weights at the ages 7, 10 and 13 years were analyzed concerning secular growth changes as well as socio-economic differences. This Stockholm study has been reported in detail by Cernerud & Lindgren (1991) and Lindgren & Cernerud (1992).

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In March–April 1990 a study on menarcheal age was conducted concerning a sample of Stockholm school girls born in 1971–80 using the status-quo-method. For a smaller group of girls born in 1971–75 within this sample, mean menarcheal age was estimated also by the recollective method. This study was reported more in detail by Lindgren et al. (1991).

Summary of Results

Heights and weights of Swedish school children born in 1955 and 1967
(Lindgren & Hauspie, 1989)

The results indicated that for girls there was a slight positive secular trend in the mean height in the age range 10–15 years between the 1955 and 1967 samples. This trend was more marked for boys (*Fig. 1*). However, for average weight, the trend was quite pronounced for both boys and girls, giving higher values of the Body Mass Index for the 1967 sample and especially so for girls in the age range 13–15 years.

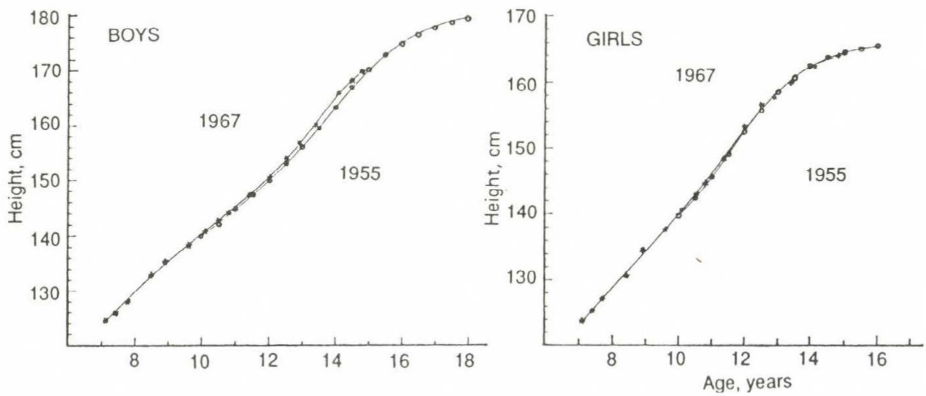

Fig. 1: Average height for boys and girls born in 1955 and 1967 (from Lindgren & Hauspie, 1989)

About the maturational rate expressed as age of maximal increment in height and weight respectively during puberty, it seemed that the trend in height and weight for boys was partly, if not wholly, attributable to an earlier maturation of the boys in the 1967 sample. For the girls this seemed to be of a lesser degree.

Secular growth changes and socio-economic differences of Stockholm schoolchildren born in 1933–1963 (Cernerud & Lindgren, 1991; Lindgren & Cernerud, 1992)

Heights and weights at the ages 7, 10 and 13 years were compared for Stockholm schoolchildren born in 1933, 1943, 1953 and 1963. The increase in height and weight at these ages was more marked between the children born in 1933 and 1943 than later, except for the girls aged 7 years, who had no increase in height. The increase in height between the later samples was at age 7 years practically none, at the age of 10 years about 1 cm/decade and at the age of 13 years 1–2 cm/decade (*Fig. 2*).

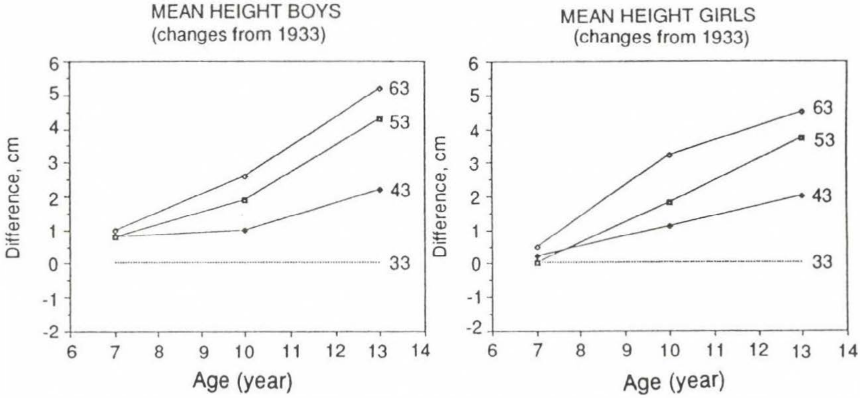

Fig. 2: Growth changes in average height at the ages 7, 10 and 13 years of Stockholm schoolchildren born in 1933, 1943, 1953 and 1963 (from Cernerud & Lindgren, 1991)

In height there were significant socio-economic differences for boys and girls born in 1933 and 1943 at the ages of 7 and 10 years; children from the lowest socio-economic group were smaller. For the cohort born in 1953 there were, however, no socio-economic differences in height – neither for boys nor for girls. For children born in 1963, socio-economic differences in height appeared again, but mainly for the boys; boys in the lowest socio-economic group were smaller (*Fig. 3*).

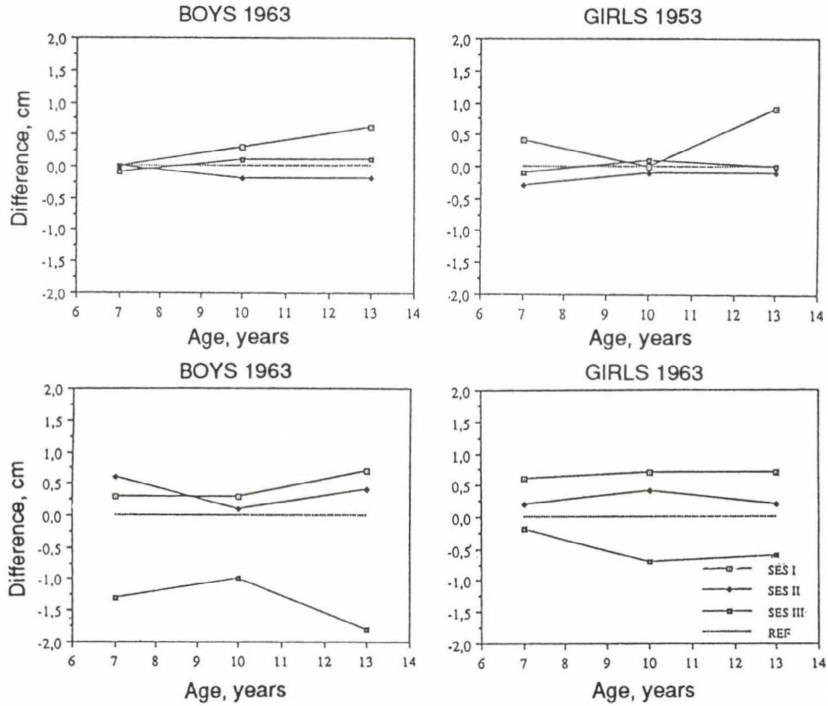

Fig. 3: Differences in mean height (cm) at the ages 7, 10 and 13 years between socio-economic groups I, II and III of Stockholm schoolchildren born in 1953 and 1963 (from Lindgren & Cernerud, 1992)

Significant weight differences between socio-economic groups were for the boys found only in cohorts born in 1943 and in 1963 and for the girls born in 1933, 1943 and 1953.

Socio-economic differences in BMI were found for boys born in 1943, when the middle socio-economic group had the lowest index and for boys born in 1963 when the highest socio-economic group had the highest index. For girls socio-economic differences in BMI were only found for girls born in 1953 when the lowest group had the highest BMI.

The main conclusions from this study were: socio-economic differences in height formerly present in Stockholm schoolchildren born in 1933 and 1943 were levelled out for the children born in 1953, but reappeared again for children born in 1963 – mainly for the boys; these socio-economic height differences for the 1963 cohort were of about the same magnitudes as those for the cohort born in 1943 during the Second World War. The influence of socio-economic background on the BMI of Stockholm schoolchildren born 1933–1963 was not so marked.

Menarche 1990 in Stockholm schoolgirls (Lindgren et al., 1991)

By the status quo-method and according to probit-analysis mean menarcheal age was 13.19 years (SD = 1.08) for girls born in 1971–80.

For the group of 205 girls born in 1971–75, thus aged 15–19 years who could recollect their menarcheal age, mean menarcheal age was 12.80 years (SD = 1.08) ranging from 9.8 years to 16.6 years (*Fig. 4*).

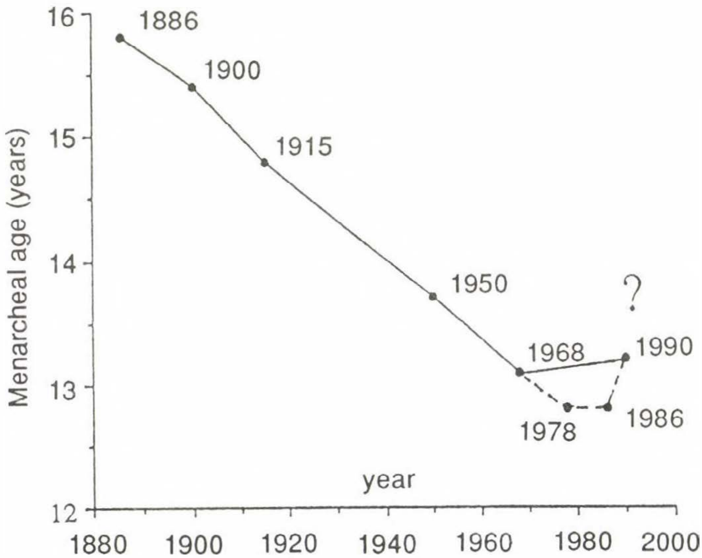

Fig. 4: Secular growth changes in menarcheal age of Swedish girls

Discussion

Secular growth changes in height and maturational rate of Swedish youth have been observed during the last hundred years. Even if the samples used for these observations have not always been strictly comparable regarding regional areas, socio-economic distributions and methods used, the overall impression has been that the secular trends have been going on since 1880 in Sweden. The results from the different growth studies referred to in this paper, however, rather clearly show that the trends in height and maturational rate of Swedish youth obviously made a halt from the end of 1970 to about 1985; it seems first in height per se and then in maturational rate, at least concerning menarcheal age.

The small but noticeable positive trend in height for Swedish schoolchildren born in 1967, compared to children born in 1955, merely seemed to be the effect of their slightly earlier maximal increment in height during puberty or PHV-age. Regarding differences in their adult height, however, it seemed that the children born in 1967 would end up somewhat shorter, although this difference was not large and one might speculate about that. The 1967 sample consisted of about 10% immigrant children compared to about 2% for the 1955 sample and immigrant children in Sweden are often shorter than Swedish children. Whether this might have had an effect on the results for the 1967 sample needs further investigations. As regards the difference in height of Swedish conscripts, those born in 1955 were on average 178.7 cm compared to those born in 1968 who were 179.1 cm. The difference was rather small and might be explained by the fact that most male immigrants were not enrolled in the Swedish army. Hence, Swedish youth born in 1967 did not seem to have become taller compared to those born in 1955. They were, however, maturing earlier as regarded their PHV-ages and they were considerably heavier.

Concerning the results for the Stockholm children born in 1933, 1943, 1953 and 1963, they indicate that the secular trend in height had continued but was slowing down. Preliminary results for Stockholm schoolchildren born in 1973 and 1983 indicate that the positive trend in height made a halt when comparing these samples to the sample born in 1963 although the positive trend in weight was still continuing like for the whole of Sweden.

Regarding Stockholm girls born in 1971–80 their mean menarcheal age by the status-quo-method was 13.19 years. Compared to this result the mean menarcheal age likewise by the status-quo-method was 13.09 years for a sample of Stockholm suburban girls born in 1951–57, indicating that the positive trend in maturational rate defined by menarcheal age had made a halt some time between 1965–85, at least for Stockholm girls. When comparing menarcheal data obtained by the recollective method the mean menarcheal age of 12.80 years for the Stockholm girls born in 1971–75 does not differ from the mean menarcheal age of 12.76 years reported in 1978 for a group of suburban Stockholm schoolgirls born in the early 1960s. Thus comparing these results derived by the recollective method the secular trend in menarche for Stockholm girls seems to have continued up to about 1978 but at this point made a halt. The somewhat different results obtained by the status-quo-method on one hand and the recollective method on the other might be an effect of girls being born in 1971–75 in the recollective study and girls being born in 1971–1980 in the status-quo-study. In conclusion it seems that the secular trend in menarche came to a halt from 1978 to about 1985.

Unfortunately the studies referred to in this paper are not representative for the whole Swedish nation. Regarding height and weight the results are representing mainly urban areas, whereas rural areas are scarcely represented. The results for the Stockholm children, however, follow – at least during the period studied here – a similar pattern regarding height and weight. The results regarding menarche represent only Stockholm, of course, but it could be hypothesized that these resuts are mirroring the trend of urban areas in Sweden.

Reasons for a halt in the secular trends in height and maturational rate of Swedish youth could be that the optimal state of the population has been reached, the demographic changes of the population or a worsening of the socio-economic conditions, in general or in different regional areas, for instance in Stockholm. Thus the hypothesis could be stated that a hundred years of ongoing positive secular trends in height and maturational rate of Swedish youth made a halt at the end of this century, although a nationwide study should be conducted taking into account different regional areas as well as the distributions of socio-economic groups and immigrants within these areas.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 23 July, 1991.

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Anthrop. Közl. *33;* 23–31. (1991)

TWINS: ITALIAN STANDARDS FOR WEIGHT, LENGTH AND HEAD-SIZE AT BIRTH

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Abstract: *Neonatal norms for weight, length and head-size of twins are presented, based on 575 reference neonates delivered, after low-risk, uncomplicated pregnancy, between 1973 and 1981 in nine hospitals of North, Central and South Italy, and included in a multicentre survey of perinatal preventive medicine. These norms are compared to those (previously published) for singletons, based upon 16336 reference babies born in the same period and included in the same survey.*

In twins, modal gestation's length is 3 weeks shorter and the percentage (43%) of preterm births is four times higher than in singletons. Pregnancy at risk does not seem to exert prominent effects on somatic growth of twins. The largest differences in body size between singletons and twins appeared to be the overlapping between singletons' 50th centile and twins' 90th centile (for weight), and the small positive difference between singletons' and twins' head circumference (2 cm) and length (3 cm). These results may suggest that the intrauterine limitations that are typical of twin pregnancies tend to depress weight gain more than bone growth.

For these reasons, the assessment of body size of twins by standards based on singletons leads to overestimate, chiefly in the case of full-term pregnancies, the proportion of babies below the reference limits which are generally accepted as warning limits. The use of neonatal standards based on twins could improve the evaluation of fetal growth and body size at birth.

Key words: *Twins; Neonatal standard; Birth weight; Birth length; Head circumference.*

Introduction

Intrauterine and neonatal growth standards are widely recognized as fundamental to a good obstetric management of pregnancies: literature presents a large variety of standards on data collected from mono or multicentre studies and suitable for monitoring fetal development and assessing the stage of maturity of neonates in different human populations. The large majority of these studies, however, concern singleton pregnancies: the available standards for twins date back to Sixties or early Seventies (Naeye et al. 1966, Wilson 1974), or refer to populations with unusually high proportion of twin births (Nnatu and Kayode 1983, Fakeye 1986) and, as to Italy, are lacking at all.

This paper presents neonatal standards for weight, length and head-size of twins, based on 575 Italian neonates born between 1973 and 1981. These norms are compared to those for singletons, based on 16336 reference babies born in the same period and included in the same survey (Bossi and Milani 1986, 1987).

Subjects and Methods

Target population and selected sample

Weight, length and head-size at birth were recorded in the "neonatal data" section of an ad-hoc questionnaire of an obstetric-pediatric multicentre survey, one of the goals of which was the definition of cross-sectional standards for Italian neonates. The survey was supported by CNR, the National Research Council (Target project: Preventive

Medicine and Rehabilitation, subproject SP1). Design of the survey, methods adopted to collect information, and data description have been presented in detail elsewhere (Bertulessi et al. 1983). It sufficies to say here that the nine hospitals in which data have been collected were placed so as to supply information on health conditions and care of mothers and babies in regions of Italy which largely differ in social or demographic features and life habits, as thoroughly discussed in previous papers (Milani et al. 1986).

Out of some 46.000 pregnancies surveyed, there were 465 twin pregnancies which yielded 932 neonates. The percentage of twin-births (1.97%) is twice the value (0.9%) reported in the same time period for Italy (ISTAT records). This finding might be ascribed to the special role of some hospitals (mainly Milan and Naples) in which the survey was carried out (*Table 1*).

Table 1. **Number of twins and percentage (in parentheses) of twins on total number of neonates, in the 9 centres participating in the survey**

CENTRE		TWINS	
TRIESTE	(Instituto Burlo Garofalo)	157	(1.48)
MILAN	(Clinica L. Mangiagalli)	333	(2.64)
PARMA	(Ospedali Riuniti)	82	(1.25)
ROME	(Policlinico A. Gemelli)	108	(1.49)
NAPLES	(Il Policlinico)	126	(3.56)
BARI	(Policlinico)	100	(2.30)
MANTOVA	(Istituti Ospedalieri C. Poma)	12	(0.73)
BELLANO	(Ospedale Civile)	8	(3.05)
MORBEGNO	(Ospedale Civile)	6	(1.13)
TOTAL		932	(1.97)

The reference babies for the standards were liveborn twins without detectable congenital anomalies; further their mothers did not have any of the risk factors identified on the questionnaire and which seem to impair fetal growth (Bossi and Milani 1986). Risk factors taken into account concern maternal history (uterine fibroids, uterine surgery, renal diseases, hypertension), previous pregnancies (spontaneous abortions, stillbirths, neonates weighing 2.5 kg or less), present pregnancy (urinary infections, lues, jaundice, diabetes, tuberculosis, asthma, endocrine and heart diseases, hypertension, eclamptic strokes, epilepsy, vaginal bleeding, placental abruptio, isoimmunization, intrauterine transfusion, smoking 10 cigarettes or more).

Variables

All measures were taken within one hour of delivery, as a part of routine care. Body weitht (BW) was recorded to the nearest 10 g. Crown-heel length (CHL) was measured with the neonate flat on its back and both legs extended in a measuring device containing a built-in centimetre rule; head-size (HC) was measured by a tape at the largest occipito-frontal circumference. Length and head-size values were recorded to the nearest centimetre. The measuring error, including both "within-neonatologist" and "between-neonatologists" components, was less than 2% (in terms of CV%). Gestational age (GA) was expressed as completed weeks counting from the first day of the last menstrual period. The estimate of gestational age was considered reliable if the date of beginning of the last menstrual period was recorded accurately, the period was normal with respect to flow, duration and expected date, and menstrual cycles preceding preg ,ancy were regular within 28 days ± 5.

Statistical Analysis

The effects of sex and pregnancy at risk on neonatal body size of twins were estimated by a proper linear model, after adjustment for the effect of gestational age (Searle 1976).

The prefixed centiles of the empirical distributions were computed by nonparametric method (Conover 1971): this makes no distributional assumption, and hence is a more general and safe method to adopt (Solberg 1981), although its efficiency is somewhat lower, chiefly for extreme centiles (Healy 1974). The estimates of centiles were then smoothed (Healy et al. 1988), so as to reduce random variability and elicit the shape of the relationship of traits to gestational age.

Results

The analysis was carried out on 807 babies (411 girls and 396 boys) out of 932, 87 stillbirths and neonatal deaths (i.e. deaths occurred in the first month of postnatal life), 32 neonates with congenital anomalies and 6 neonates without reliable gestational age having been excluded. *Figure 1* reports the frequency distribution for gestational age in girls and boys. In both sexes, gestation's length is less than 37 weeks for some 43% of twins, and the maximum frequency of births occurs on the 37th week.

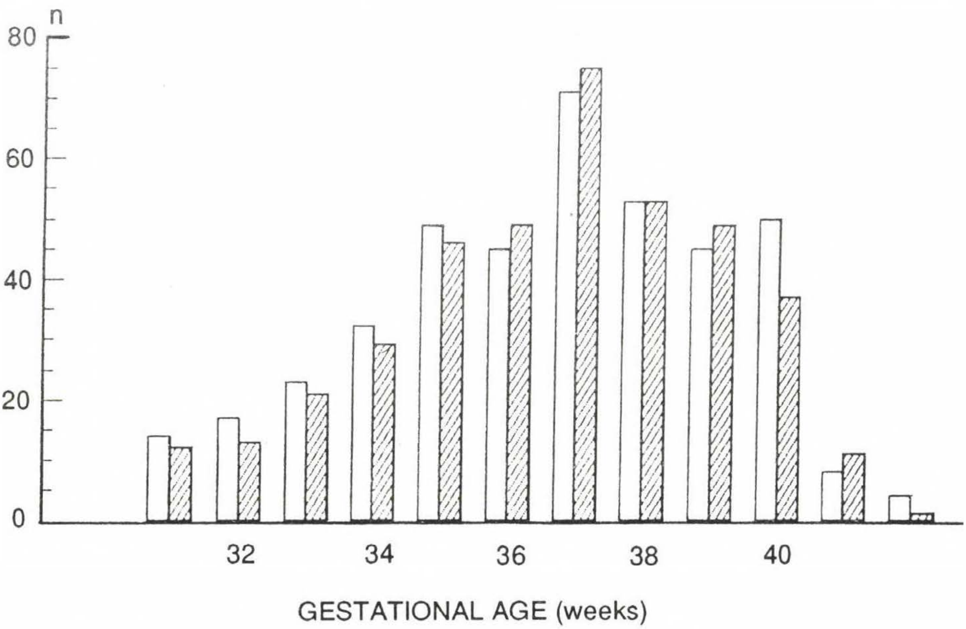

Fig. 1: Distribution of gestational age in girls (empty columns) and boys (dashed columns)

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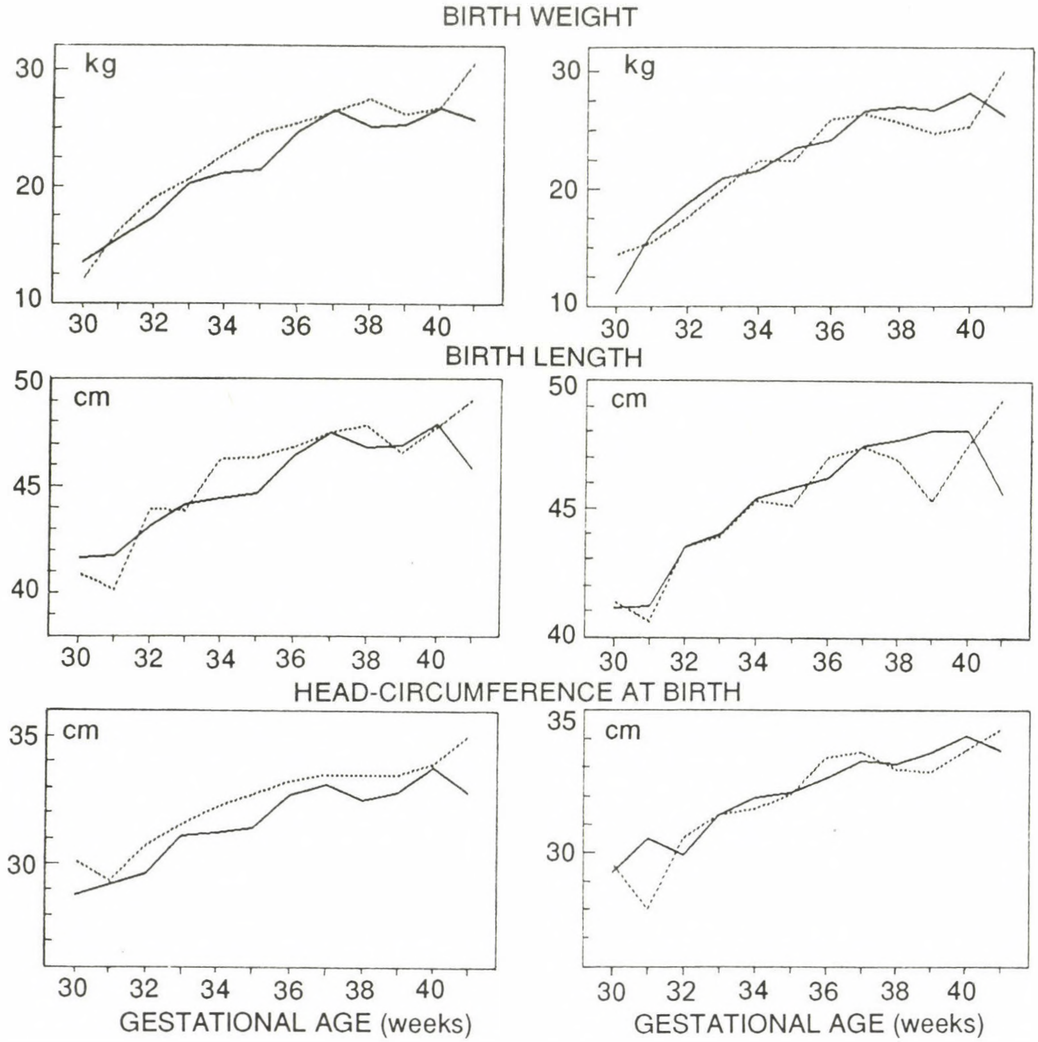

Fig. 2: Mean values of morphometric traits in girls (solid line) and boys (dashed line) on the left, and in reference (solid line) and at risk (dashed line) groups on the right

The sample was made up of 575 reference neonates, and 232 neonates whose mothers have at least one of the risk factors mentioned above. Results of the analysis of variance show that, at birth, boys have body weight and head-circumference significantly larger than girls, but not length. Actually, in the range 32–39 weeks of gestation, the median differences range from 0.1 to 1.2 cm for length, from 0.4 to 0.7 cm for head-size and from 80 to 200 g for weight. Pregnancy at risk does not appear to exert large effects on somatic growth of twins, though there may be differences between reference and at-risk groups in the shape of the relationship of all traits to gestational age (*Fig. 2*). It is worth noting that the unexplained between-pregnancies variability (BW: 480 g; CHL: 3.1 cm;

HC: 1.7 cm) it is 1.3–1.5 times the unexplained within-pregnancy variability (BW: 330 g; CHL: 2.4 cm; HC: 1.3 cm). On the basis of the above findings, it seemed to be sensible to compute neonatal standards for twins separately for reference girls (303) and boys (272).

Neonatal norms for twins in *Table 2* are expressed as selected centiles (5, 10, 50, 90 and 95) of the distribution of body weight, crown-heel length and head circumference, between 32 and 41 weeks of gestation.

Table 2. **Centiles of the distribution of body weight (g), length (cm) and head-size (cm) at birth, by Gestational Age (GA)**

GA (wks)	No	CENTILES GIRLS 5	10	50	90	95	No	CENTILES BOYS 5	10	50	90	95
						Body Weight						
32	12	1199	1297	1813	2309	2393	11	1057	1247	1894	2353	2423
33	17	1360	1468	1985	2487	2585	19	1262	1444	2082	2561	2642
34	18	1510	1628	2147	2654	2765	17	1455	1629	2259	2758	2849
35	34	1645	1773	2293	2806	2930	32	1633	1799	2420	2940	3042
36	36	1760	1899	2420	2939	3076	32	1792	1950	2563	3103	3215
37	46	1853	2002	2524	3048	3199	45	1927	2078	2682	3243	3365
38	45	1918	2077	2600	3130	3294	34	2036	2178	2774	3355	3488
39	35	1951	2121	2645	3181	3358	31	2112	2247	2834	3436	3579
40	38	1949	2129	2655	3196	3386	32	2153	2280	2859	3481	3635
						Crown-Heel Length						
32	11	37.2	38.7	43.3	46.7	47.4	8	39.0	39.9	43.4	46.2	46.7
33	17	38.6	39.9	44.1	47.3	48.0	15	40.4	41.3	44.6	47.1	47.6
34	18	39.9	41.1	44.9	47.9	48.6	14	41.7	42.6	45.6	48.1	48.5
35	28	41.1	42.2	45.6	48.5	49.2	31	42.8	43.7	46.6	48.9	49.4
36	35	42.2	43.2	46.3	49.1	49.8	32	43.7	44.5	47.4	49.7	50.2
37	44	43.0	43.9	46.8	49.6	50.4	42	44.2	45.1	47.9	50.3	50.8
38	45	43.6	44.5	47.1	50.0	50.9	33	44.5	45.5	48.3	50.7	51.3
39	33	44.0	44.7	47.3	50.2	51.2	30	44.5	45.5	48.4	50.9	51.6
40	37	44.0	44.8	47.3	50.3	51.4	32	44.1	45.1	48.2	50.8	51.6
						Head Circumference						
32	11	26.8	27.6	30.0	31.9	32.4	10	27.9	28.6	30.7	32.6	33.1
33	16	27.8	28.5	30.9	32.8	33.3	15	28.9	29.5	31.5	33.4	34.0
34	18	28.6	29.3	31.6	33.5	33.9	16	29.7	30.3	32.2	34.1	34.7
35	31	29.2	29.9	32.1	34.0	34.4	30	30.3	30.9	32.7	34.6	35.2
36	33	29.7	30.3	32.5	34.3	34.8	32	30.7	31.3	33.0	34.9	35.6
37	45	30.1	30.7	32.8	34.5	35.0	42	31.1	31.6	33.3	35.2	35.8
38	45	30.4	31.0	33.0	34.7	35.2	33	31.4	31.9	33.5	35.4	36.1
39	33	30.7	31.3	33.2	34.9	35.4	30	31.7	32.2	33.6	35.5	36.2
40	36	31.0	31.5	33.4	35.1	35.6	32	32.0	32.4	33.8	35.7	36.5

In girls, body weight increases from 1.8 to 2.7 kg (50%) between the 32nd and the 40th gestation week, in the same period length and head-size increase from 43.3 to 47.3 cm and from 30.0 to 33.4 cm (i.e. some 10%), respectively. In boys, body weight increases from 1.9 to 2.9 kg (50%), whereas length and head-size increase from 43.4 to 48.2 and from 30.7 to 33.8 cm (10%), respectively. For all traits, most of the gain occurs in the range 32–37 weeks, and between-babies (within gestation's week) variability is very large: the range between centiles 5 and 95 is some 1.5 greater than the median growth between the 32nd and the 40th week of gestation.

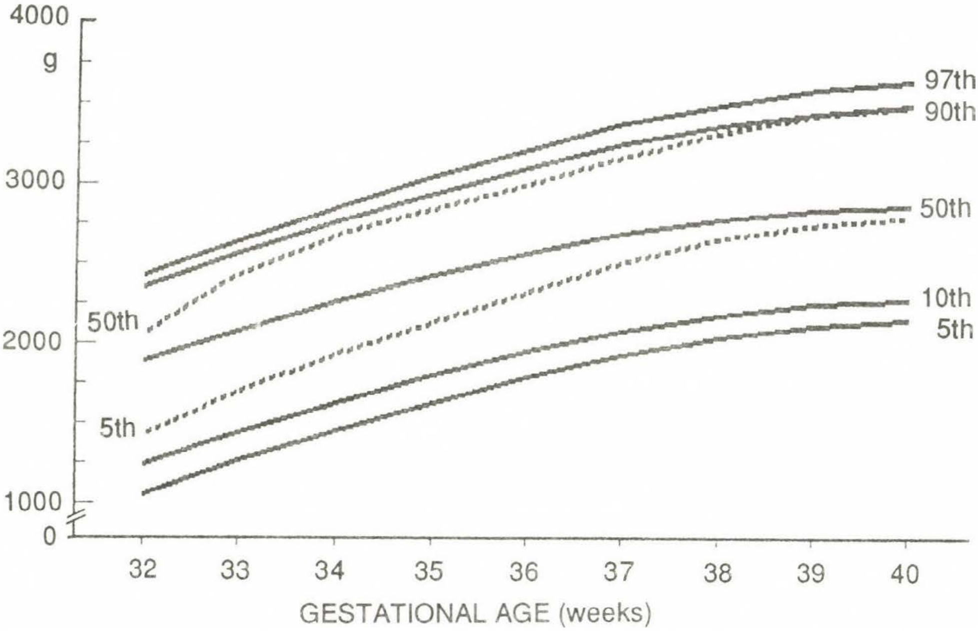

Fig. 3: Comparison between standards for birth weight in twins (solid line: 5th, 10th, 50th, 90th, 95th centiles) and in singleton (dashed lines: 5th and 50th centiles), for boys

Differences in birth weight between twins and singletons increase with gestational age (from 0.3 to 0.7 kg between 32 and 40 weeks). At all gestational ages and for both sexes, the 90th centile of twins is rather similar to the 50th centile of singletons (see *Figure 3* as an example). The differences in length or head size are lower, and the 50th centile of singletons are consistently below the 90th centile of twins.

Discussion

Above results show that modal gestation's length is in twins 3 weeks shorter than in singletons included in the same survey: analogous results are given in literature (Bleker et al. 1979, Hemon et al. 1982). The percentage (43%) of preterm births (i.e. births occurring before 37 weeks) is in twins four times higher than in singletons (Bertulessi et al. 1983): similar or slinghtly lower percentages of preterm births among twins are reported by other authors (Koivisto et al. 1975, Keith et al. 1980, Secher et al. 1985).

Pregnancy at risk does not seem to exert prominent effects upon somatic growth of twins. This unexpected finding might be ascribed to several causes: (1) risk factors differ largely as to severity, (2) risk factors could affect gestation length more than size at a given gestational age, (3) severe impairment of somatic growth is more likely to yield fetal death and stillbirths in twins than in singletons and, therefore, to be unobservable.

Neonatal standards for twins, as well as those for singletons presented in previous papers (Bossi and Milani 1986, 1987), were based on reference babies selected according to clear-cut criteria. Not only stillbirths and neonates with congenital anomalies were excluded, but also all babies whose mothers had any known risk factor for pregnancy or outcome, connected with impaired fetal growth. Furthermore, since information on ultrasound assessment of gestational age was not available, the strict criteria mentioned in section "Variables" were adopted to try to ensure the reliability of gestational age's estimates in the reference sample. Because of this selection, the reference babies were only one third of all singletons (in particular, GAs estimates were considered unreliable for some 33% of the excluded neonates), with a small proportion of preterm neonates (less than 10%). Nevertheless, some reference babies (mainly before 35 gestation weeks) had size too large for their GA: the persistence of similar inconsistencies was observed also in other surveys where GA was assessed by ultrasound (Yudkin et al. 1987). In any case, the effects of possible errors in GA values (mainly as regards the estimate of 90th and 95th centiles) appeared to be much lower in reference twins than in singletons: this fact and the use of a new method of smoothing (Healy et al. 1988) resulted in the rather regular shape of twin norms here presented.

Between-sexes differences in weight are slightly lower for twins than for singletons: in other terms, the effects of twin pregnancy on birth weight seem to be larger for boys (Guttmacher and Kohl 1958). As to body size, sex related differences were found by Berman et al. (1987), but not by Newton et al. (1984) who analysed data from 1126 babies born in 13 hospitals between 1970 and 1975. From the latter study, it emerged that average length of gestation is shorter for pairs of male twins than for pairs "female–female" or "female–male". In the sample analysed in the present study, no difference of this kind was apparent.

The differences in body size between singletons and twins appeared to be roughly similar to those reported by Wilson (1974), with particular regard to the overlapping between singletons' 50th centile and twins' 90th centile (for weight), and to the small positive difference between singletons' and twins' head circumference (2 cm) and length (3 cm). However, this Author pooled data from girls and boys together (299 boys and 298 girls, born in 8 hospitals of USA), and compared twins and singletons who were not included in the same survey, nor belonged to the same population. These results may suggest that the intrauterine limitations that are typical of twin pregnancies tend to depress weight gain more than bone growth.

Studies carried out by Stefos et al. (1989), Keith et al. (1980), and Simon et al. (1989) show that twins' limited growth does not depend on genetic factors, but relates to differences in feto-placental unit concerning oxigenisation of blood removal of waste products, production of essential metabolites, vascular perfusion, placental metabolism. Therefore, birth weight differences in a pair of twins could suggest different uterine vascularization when there are two placentas, otherwise, different hematic distribution between twins when there is one placenta only (Naeye et al. 1966). Unfortunately, the number of placentas had not been recorded during the survey, so that the effect of this factor on twin's growth could not be analysed.

It is widely accepted that limitations given by nutritional support tend to reduce fetal growth of twins, with respect to singletons, after 28–30 weeks of gestation (Hendriks 1966, Naeye et al. 1966, Wilson 1974, Hemon et al. 1982, Secher et al. 1985, Bleker et al. 1988, Simon et al. 1989, Stefos et al. 1989). Further, there are limits to uterus' development that are expected to inhibit somatic growth of twins after 36–37 weeks: this seems to be confirmed by the progressive approach of twins' median value to singletons'

5th centile for all traits here examined. For these reasons, the assessment of body size of twins by standards based on singletons leads to overestimate, chiefly in the case of full-term pregnancies, the proportion of neonates below the reference limits which are generally accepted as warning limits.

Acknowledgments: This work was suppported by the Consiglio Nazionale delle Ricerche: target project "Preventive Medicine and Rehabilitation", subproject "Perinatal Diseases and their Sequelae" (grant number 85.0060.56). We are grateful to Professor JM Tanner for his advice and helpful suggestions.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 22 July, 1991.

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Anthrop. Közl. *33;* 33–39. (1991)

DESCENDANT' STATURES AS DETERMINED BY SEX DIFFERENCES APPEARING IN PARENTS' STATURES?

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Abstract: *The authors examined the above question in a relatively endogamous "small population" of a village in Northeastern Hungary, called Turricse. Altogether 155 adult males and 199 adult females (all above the age of 18 years) were involved in the analyses, which represented the 62.5 and 70.1 percents of adult population, respectively. Standardization according to age were accomplished by linear regression after a preliminary testing.*

According to the results in father-sibling (son or daughter) correlation the greater was the sexual difference between the parents the smaller was the sibling's body height. Relating to the mother the direction of the above correlation was just the opposite. The influence of sexual difference is opposite in direction but balanced in dimension in both sexes. However, the question of to what extent the distribution of the siblings' statures depend on the distribution of the parents' sexual differences in samples differing from the examined in inbreeding is still open.

Key words: *Inheritance of stature; Parents–siblings correlations; Sex difference.*

Introduction

It was Galton (1889) who first published the results of his researches on the manifestation of stature in adult age and its genetic backgrounds.

The degree of the influence of environmental factors has not been fixed yet unambiguously in spite of the knowledge of a good few standard works of reference (Dahlberg, 1926; Lentz, 1935; Rieman, 1938; Werner, 1938; Ito, 1948; Vogel and Wendt, 1956).

Investigations related to the inheritance of stature can be assorted according to certain standpoints of approach (Knußmann, 1968). These cover partly twin-examinations (Verschuer, 1951; Csík and Apor, 1936; Osborn and de George, 1959; Kimura, 1956), partly analyses of stature-correlations of parents and siblings (Pearson and Lee, 1903; Finney, 1939; Tanner and Israelsohn, 1963; Bieliczki and Welon, 1966). Another respect of investigations like these was established by Gates' family-examinations (1949).

In the field of statistical comparative analyses Garn's basic experiments (1962) opened up new vistas in the history of researches.

The present paper attempts to analyse such a new aspect of the question, which, as far as we know, has no traditions in the history of the science. Namely, we attempt to analyse the question of whether the difference in parents' statures influences the body height of their descendants (sons and daughters).

Material and Method

We carried out our examinations on a small and relatively endogamous population on the basis of data measured in 1971. This settlement is sited in Northeastern-Hungary

(Szabolcs-Szatmár-Bereg county) and belongs to the category of the so-called "small populations". The distribution of population and sampling is shown in *Table 1*.

Table 1. **Number of inhabitants in Turricse population (Census 1970) and sampling**

	Total population in Turricse 863	
	Male 425	Female 438
Individuals above 18 years of the total sample:	248	284
Individuals (above 18 years) examined:	155 (62.5%)	199 (70.1%)

It is a fact of common knowledge that stature largely depends on the age of the individual. Consequently, first we tested the distributions of the total samples, then determined the linear regressions most characteristic of the distributions. In this way we could evaluate data comprehending two generations at least.

As a result of measuring the 155 males it could be established that body height above the age of 18 years decreased significantly according to the age on the level $p<0.001$ ($y= -0.151\ x + 172.76$; $r = 0.398$). The same could be experienced in the case of the 199 examined females ($p < 0.001$; $y = -0.142x + 159.79$; $r = 0.398$).

Thus, according to the regression determined on the basis of the total sample it became obvious that for further examinations the statures of each individuals should be standardized with reference to an optional age. This was fixed at 18 years of age as this was the lowest age-limit for sampling. However, standardization was not accomplished in the case of each individual, instead those individuals above the age of 18 (that is, 33 sons and 35 daughters) were chosen from the total sample whose parents' body heights both were known.

In this way we were able to examine father–son, father-daughter, mother-son and mother-daughter stature-pairs taken as functions of the differences of the parents' statures owing to their sexual differences.

In order to standardize for the age of 18 years, linear regression was first corrected on the basis of stature-decrease characteristic of the whole population.

Males:

$$y = -0.151\ X + 172.76$$

$$y^{18} = -2.72 \quad + 172.76 = 170.04$$

$$\boxed{-0.151 \times 18}$$

Females:

$$y = -0.142\,X + 159.79$$

$$y^{18} = -2.56 \quad + 159.79 = 157.23$$

-0.142×18

where X = years.

In the course of this, besides the establishment of the constant values, we could determine, taking the age into consideration, the distance of the parents and their sons, daughters taking part in the present concrete analysis on the basis of the total sample, applying the following formulas:

$$D_y = y_r - y_o$$

where y_r = stature at a certain age estimated by the regression line of the total sample; y_o = original stature measured at a certain age.

$$y^x_{stand} = y^{18} - D_y$$

Males: $y^x_{stand} = 170.04 \qquad (-0.151\,X + 172.76) - y_o$

Females: $y^x_{stand} = 157.23 \qquad (-0.142\,X + 159.79) - y_o$

where X = years.

This standardization was therefore realized in each of the parent-sibling pairs.

Results

In the case of a father–son relation, the greater is sexual difference in stature between the two parents, the smaller is the son's body height, related to his father's stature. On the other hand, the less sexual difference in stature is, the more the son's stature will surpass the father's body height. This correlation looks very significant in the demonstrated linear regression (*Fig. 1*).

There seems to be a similar correlation in father–daughter relation, however, there are only a few cases known with values above 100 percent. The greater the sexual difference in stature is, the smaller the daughter's stature will be compared to her father's height. This correlation is also considerably significant (*Fig. 2*).

Relating to the mother the direction of the above correlation is just the opposite. In our sample the stature of the son surpasses that of the mother in each of the cases. The greater the sexual difference in stature is, the taller the sons relatively will be. Regression is significant in these cases, as well (*Fig. 3*).

The correlation of mother and daughter is also similar. The less the sexual difference in the parents' statures is, the smaller stature the daughter will have and the greater the sexual difference is, the more the daughter surpasses her mother's height. A significant correlation could be observed in this case, as well (*Fig. 4*).

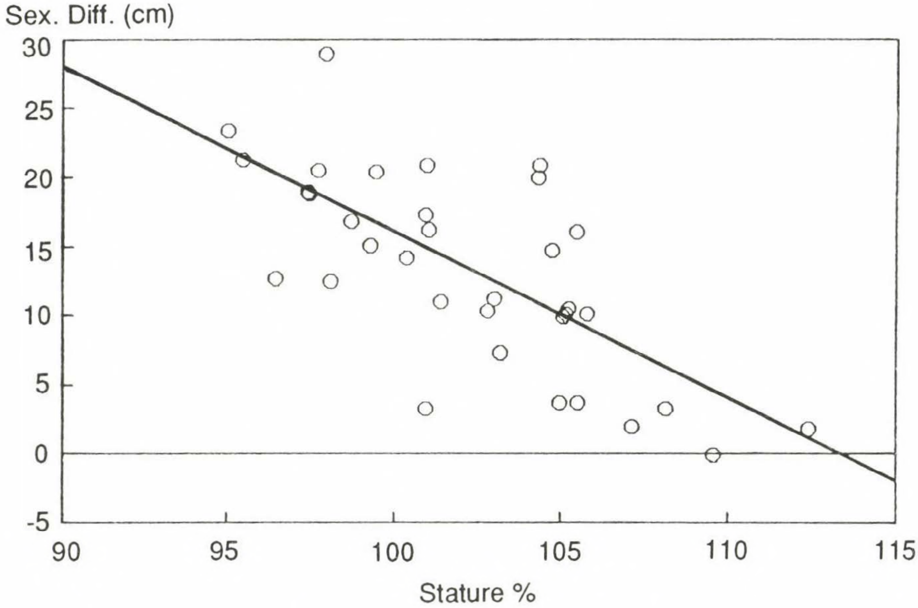


Fig. 1: Father—son correlation ($r = 0.685$; $P < 0.001$)
In all of our next figures the x-axis represents the descendants', sons' and daughters' standardized body height in the percentage of one of the parents' standardized statures. In Figure 2, for example the stature of the son is referred to that of the father. While the y-axis represents the difference between the standardized statures of the two parents, that is, the sexual difference in stature

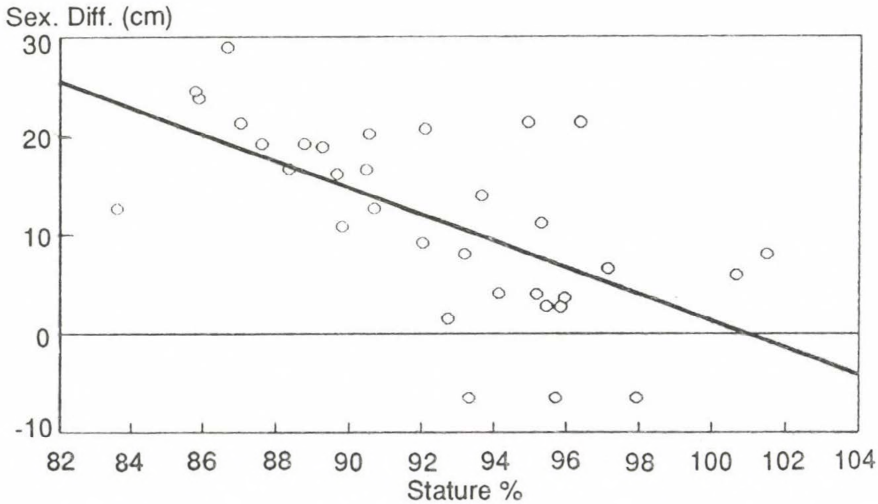


Fig. 2: Father—daughter correlation ($r = 0.624$; $P < 0.001$)

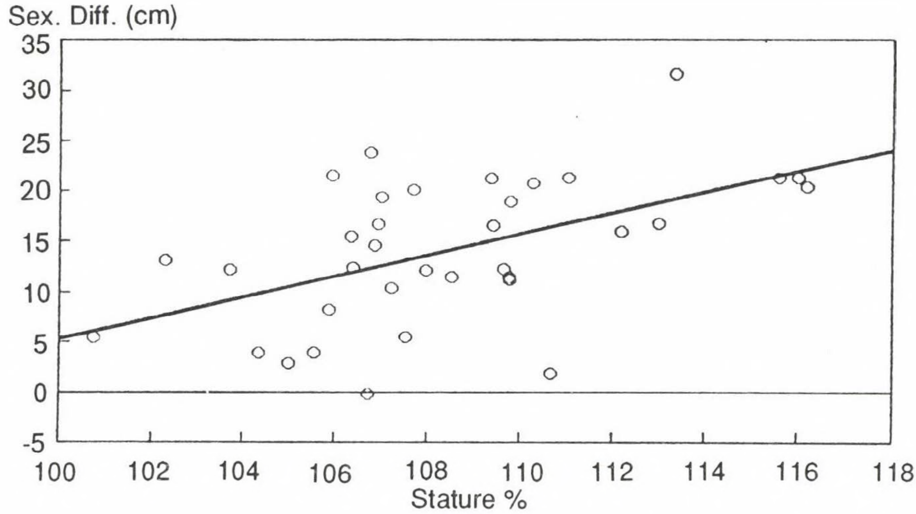


Fig. 3: Mother–son correlation (r = 0.519; P < 0.001)

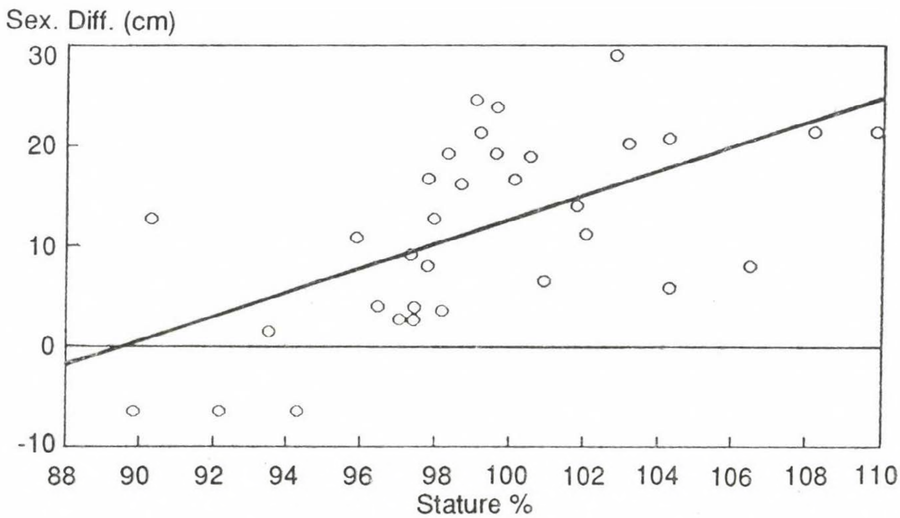
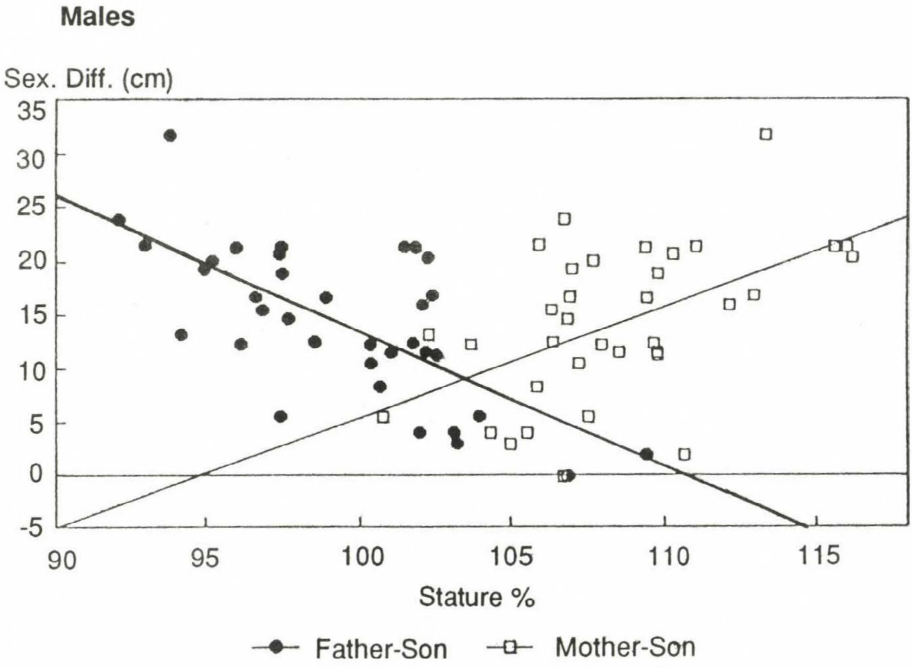


Fig. 4: Mother–daughter correlation (r = 0.585; P < 0.001)



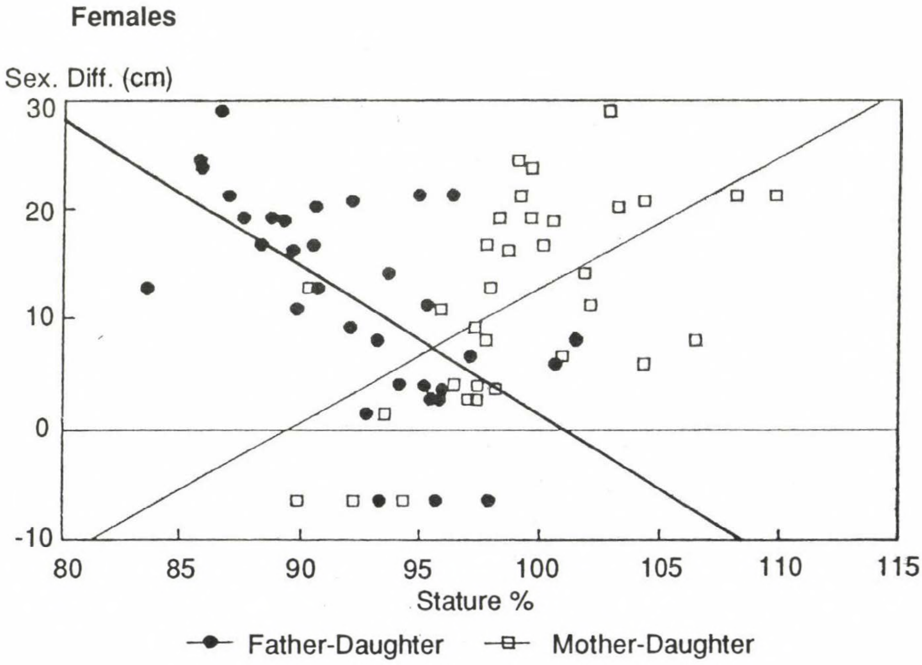


Fig. 5: **A summary of tendencies comparing the two sexes**

The correlations discovered above represent (through some sort of inside-machinery) the manifestations of the siblings' generational stature, taken as functions of sexual difference, which can be interpreted within a relatively endogamous population. This inside-machinery can be illustrated better in the summary of *Figure 5*. In the figure the points of intersection of the two lines in the case of the two sexes differ proportionally. Projecting these onto the x-axis, they show about 104 percent in males and about 96 percent in females. As the distances from the 100 percent in the cases of the two sexes are similar in measure but opposite in direction it seems that the factors behind this sexual difference become balanced.

Furthermore it is suggested that the distribution of the parents' sexual differences in stature may considerably influence the siblings' stature-distribution.

On the basis of this discovery quite a few further series of research work can be initiated. First that should be examined to what extent the regularities we have newly realized can be confirmed in populations of different inbreedings. Furthermore in selective (extreme) samples it should be analysed how these newly discovered tendencies work.

*

Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 23 September, 1991.

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Anthrop. Közl. *33;* 41–44. (1991)

HEIGHT STANDARDS OF CHILDREN AT AGES 2 TO 16 ALLOWING FOR HEIGHT OF PARENTS, BASED ON THE "BUDAPEST LONGITUDINAL GROWTH STUDY"

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Abstract: *Based on a longitudinal study of children in Budapest the authors investigated the relationship between the height of 588 boys and 665 girls and that of their parents. We determined the correlation of the children's height measurements with those of fathers, mothers and the mid-parent height. Highest correlation has been found with mid-parent height (r = 0.44 – 0.59). Linear regression parameters have been determined yearly from age of 2 to 16 according to the method of Tanner et al. Based on these parameters height standards of the children have been constructed.*

Key words: *Budapest Longitudinal Growth Study; Mid-parent height.*

In the course of the Budapest Longitudinal Growth Study, carried out between 1970 and 1988 the height measurements of the children's parents have also been recorded, thus making possible the analysis of the correlation between the height of children and their parents. During these 19 years of investigation we analysed the data of those children only, whose height was measured each year and the height of their parents was known as well. Altogether 1253 cases, the height measurement data of 588 boys and 665 girls and of their parents have been investigated. The model can be accepted to be representative for the population of Budapest.

From the methodological point of view a problem was caused due to the sampling technique used, since the height measurement data of the children related to different ages, having been fixed at the time of the measurements though the dates of birth of the children were distributed consistently in the 12 months of the year. As a consequence the height measurement data relative to exact ages could be estimated only by an interpolation within ± 6 months.

Insofar as the interval of the interpolation ranged from 1 to 6 months, the possibility of an error in the interpolation was little. We used various methods of interpolation: parabolic, exponential and linear methods; at ages 1 to 4 years the exponential, from age 5 years the parabolic or linear interpolation proved most suitable. It is to be remarked that there was only a minor (maximum 4 mms) difference between the results of the parabolic and linear interpolation.

Based on the height measurement data interpolated into ages 2 to 16 years, as well as on the height measurement data of the parents we computed correlation and regression. We investigated the correlation between the height of father–son, father–daughter, mother–son, mother–daughter at ages 2 to 16 years.

The value of the correlation coefficient ranged between 0.37–0.49, there were no significant differences between the mentioned groups of any ages. We must mention that for the correlation of the height of the father and the mother we got a value of 0.37, which means a very significant correlation.

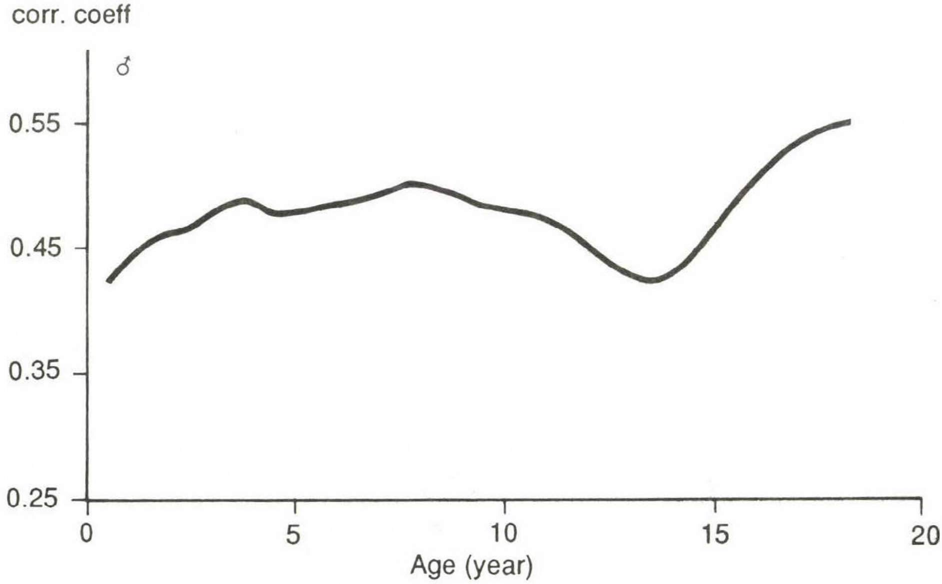

Fig. 1: Correlation of children's height with mid-parent height, based on the "Budapest Longitudinal Growth Study". Boys (n = 588)

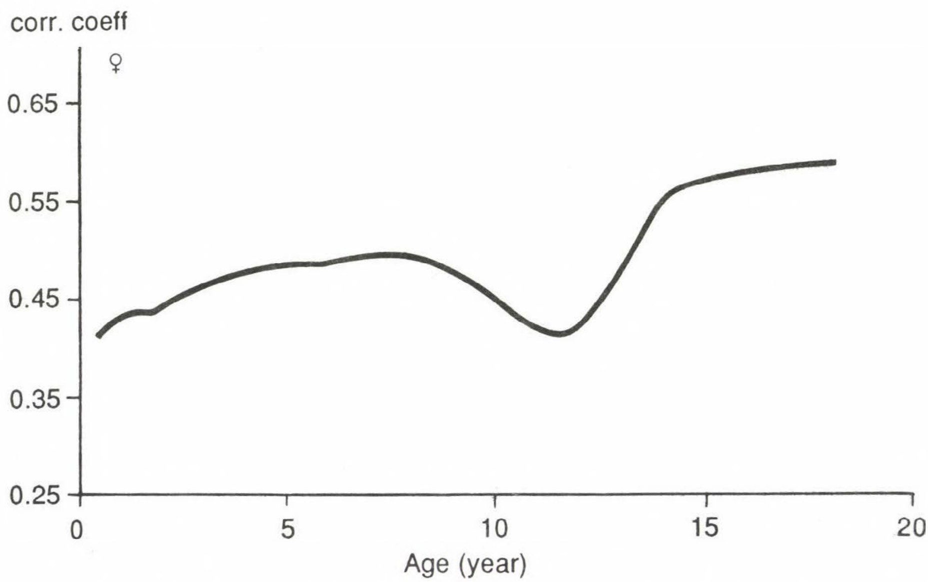

Fig. 2: Correlation of children's height with mid-parent height, based on the "Budapest Longitudinal Growth Study". Girls (n = 665)

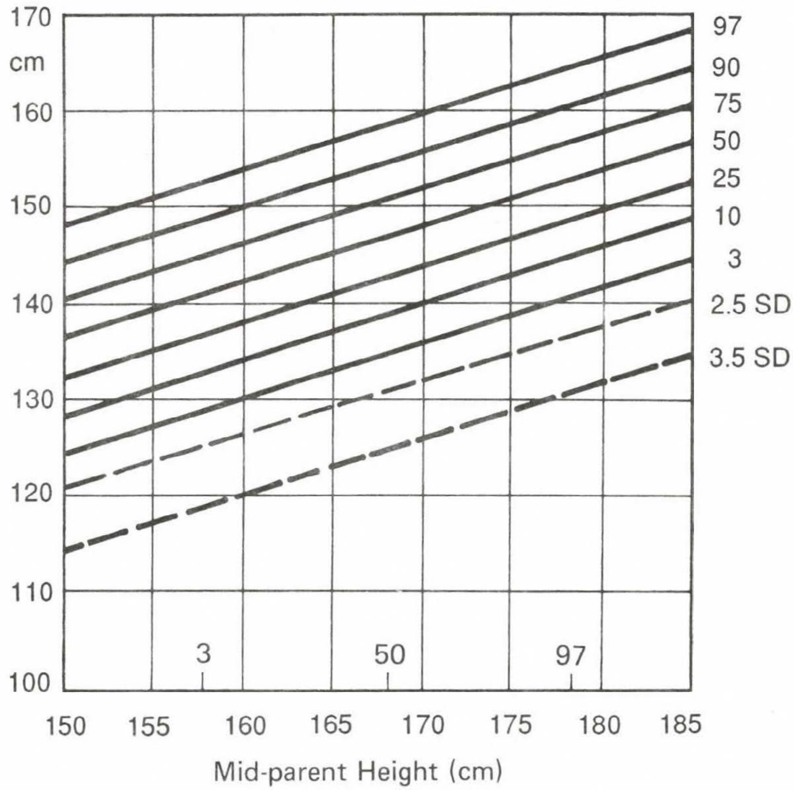

Fig. 3: Height Standards of 11 year old girls allowing for mid-parent height
(n = 665; Y = 60.7 + 0.503 * X; var (r) = 38.85)

We Investigated the correlation between the mid-parent height and the height of children, on the basis of the publications of Tanner and cos. The values of the correlation coefficients are demonstrated by *figures 1* and *2*. The correlation is much closer than that between father–child and mother–child.

Figure 1 shows the correlation coefficient of the height of the 588 boys and their parents, its values are between 0.44 and 0.55 at ages 2 to 18 years. It is well demonstrated that the correlation in adolescence temporarily decreases, due to the alteration of growth rate.

Figure 2 shows the correlation between the height of 665 girls and of their parents at different ages. The value of the correlation coefficient is between 0.44 and 0.59 at the ages 2 to 18 years. The decrease of the correlation in the case of girls is more expressed than that in the case of boys.

For evaluating the healthy growth of children the consideration of the height of parents is essential/important. On the basis of computing the regeession between the mid-parent height and the height of their children, we determined the height standards of the children in Budapest at the ages 2 to 18 years.

Figure 3 shows the height standards of girls at the age of 11 years plotted against the mid-parent height. The abscissa represents the mid-parent height (between 150–185 cms), the ordinate the height of the child. The regression line

$$y = 60.7 + 0.503 * X$$

determines the 50 percentile line, while the 97, 90, 75, 25, 10 and 3 percentile values can be estimated on the basis of the regression variance, according to the normal distribution. The value of 2.5 and 3.5 SD are also demonstrated as the critical limits, indicating growth disorder. The x-axis shows the 50 percentile value of mid-parent height (168.5 cms), as well as the 3 and 97 percentile values (158.4 and 178.6 cms).

Similarly to this figure we prepared the standard height chart at the ages 2 to 5 years on a semi-annual basis, and at the ages 5 to 16 years on an annual basis, by sexes.

According to the method publicated by Tanner et al. It is possible to chart the reference height standard of numerous groups of ages on the basis of the standardization of the regression coefficients. The estimations have been done, however, the computed charts hawe not been finished yet, so we cannot present/display them now.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received June 5, 1991.

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Anthrop. Közl. *33;* 45–54. (1991)

SOCIOECONOMIC DIFFERENCES IN HEAD MEASUREMENTS IN HUNGARIAN UNIVERSITY STUDENTS

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Abstract: *Four head measurements (head length, head breadth, morphological facial height and bizygomatic breadth) as well as two indices (cephalic and morphological facial index) were analysed in a sample of 6894 male and 1386 female university students who were measured between 1976–1985 at the Polyclinic of the Technical University, Budapest. Differences were found in the data according to the place of birth and according to the educational level of the parents of the students, too.*

Key words: *Hungarian university students; Socioeconomic factors; Head measurements*

Introduction

The effects of the socioeconomic factors to the body measurements is a well-known phenomenon all over the world. However, concerning the effects of these factors to the head measurements there is much less data in the literature. Some authors found relationship between the head form and climate (Beals 1972) or with the inbreeding (Schwidetzky 1973) or with the urbanisation (Pálsson – Schwidetzky 1973) which shows that several factors may influence the head measurements.

The aim of this paper is to provide some data about the connection of the head measurements and two socioeconomic factors.

Material and Methods

First year students from ten succesive classes were investigated between 1976–1985 at the Polyclinic of the Technical University Budapest (6894 male, 20 year old, and 1386 female, 19 year old). Head length, head breadth, morphological facial height and bizygomatic breadth were measured and two indices, the cephalic and the morphological facial index were calculated. Among the several socioeconomic factors only the birth place of the students and the educational level of their fathers were taken into consideration.

According to their birth-place the sample was divided into two groups: born in Budapest and born out of Budapest. According to the educational level of their fathers the sample was divided into three groups: 1. fathers with elementary schooling; 2. fathers with secondary schooling; 3. fathers graduated in college or university.

The measurements were taken by Martin's technique (Martin–Saller 1957) and the statistical analysis of the subgroups was made by Students's test, variance analysis and chi-squared test.

Results

Corresponding to the sexual dimorphism, the measurements of the male students are with 7–9 mm larger, than that of the female students (*Table 1*). At the same time we found no differences in the classes of Lebzelter and Saller classifications between the two sexes except of the bizygomatic breadth, where the males belong to the medium broad, while the females belong to the broad category.

According to the *birth place of the students* the values of the breadth measurements are higher among the students born out of Budapest, while the values of the head length and the morphological facial height are higher among the students born in Budapest. Therefore the values of the cephalic index are also higher among the students born out of Budapest, and their face are wider, than the face of the students born in Budapest. The majority of the differences is significant (*Table 2*).

The distribution of the categories of the *cephalic index* in the students according to their place of birth shows significant differences between the two subgroups in both sexes. It is caused by the different frequencies of the brachycephaly, which is much more higher among the students born out of Budapest, than among the students born in Budapest. All the differences are significant (*Table 3*).

The distribution of the categories of the *morphological facial index* of the students shows that the frequency of leptoprosopy is higher among the students born in Budapest, than those of the students born out of Budapest both in male and female students and the differences are significant (*Table 4*).

According to the *educational level of the fathers of the students* the lower the educational level of the fathers the smaller the values of the head length, morphological facial height, and morphological facial index; in the case of head breadth, bizygomatic breadth and cephalic index can be seen the opposite tendency. The differences are significant (*Table 5*).

The distribution of the categories of *cephalic index* of the students shows that the higher the educational level of the fathers the higher the frequency of dolichocephaly, and the lower is the frequency of brachycephaly. The students with fathers of lower educational level show the opposite tendency (*Table 6*).

The distribution of the categories of *morphological facial index* is also similar to the distribution of the cephalic index. The higher the educational level of the fathers the larger the frequency of leptoprosopy and the lower the frequency of euryprosopy. The differences are significant (*Table 7*).

Table 1. **Data of head measurements and indices in Hungarian female (n = 1386) and male (n = 6894) university students investigated between 1976–1985**

Measurements and indices	Female students Means	SD	Categories*	Male students Mean	SD	Categories*
Head length	181.29	6.37	long	190.57	6.63	long
Head breadth	151.74	5.46	broad	158.67	5.99	broad
Bizygomatic breadth	135.50	4.80	broad	142.94	5.07	medium broad
Morphological facial height	112.76	5.75	medium high	121.05	6.39	medium high
Cephalic index	83.81	4.32	brachycephalic	83.34	4.18	brachycephalic
Morphological facial index	83.28	4.57	mesoprosopic	84.74	4.83	mesoprosopic

*According to Lebzelter and Saller

Table 2. **Head length (M.1), head breadth (M.3), bizygomatic diameter (M.6), morphological facial height (M.18), cephalic index (M.3:1) and morphological facial index (M.18:6) of the 19 year old female and the 20 year old male university students investigated between 1976–1985 according to their place of birth**

Martin's No.	Female students					Male students				
	Born in Budapest (n = 645)			Born out of Budapest (n = 741)		Born in Budapest (n = 2749)			Born out of Budapest (n = 4145)	
	M	SD	P	M	SD	M	SD	P	M	SD
M.1	182.04	6.73	+	180.59	5.98	191.65	6.88	+	189.87	6.35
M.3	150.28	5.44	+	153.01	5.15	157.04	6.06	+	159.77	5.67
M.6	134.63	4.80	+	136.28	4.66	142.18	5.05	+	143.48	5.03
M.18	112.90	5.70		112.62	5.78	121.39	6.36	+	120.85	6.40
M.3:1	82.67	4.46	+	84.82	3.94	82.04	4.32	+	84.21	3.85
M.18:6	83.92	4.40	+	82.70	4.62	85.44	4.82	+	84.28	4.78

+Significant at the $P < .001$ level of probability

Table 3. **The frequency of the categories of the cephalic index in the 19 year old female and 20 year old male university students investigated between 1976–1985 according to their place of birth**

Categories of the cephalic index	Female students						Male students					
	Born in Budapest[1]		Born out of Budapest[2]		Altogether		Born in Budapest[1]		Born out of Budapest[2]		Altogether	
	n	%	n	%	n	%	n	%	n	%	n	%
Dolichocephalic	66	10.2	17	2.3	83	6.0	210	7.6	73	1.8	283	4.1
Mesocephalic	230	35.7	159	21.5	389	28.1	955	34.7	747	18.0	1702	24.7
Brachycephalic	349	54.1	565	76.2	914	66.0	1584	57.6	3325	80.2	4909	71.2
Total	645	100.0	741	100.0	1386	100.1	2749	99.9	4145	100.0	6894	100.0

[1, 2] Differences between the birth-places are significant at the $P < .001$ level of probability *in all cases*

Table 4. **The frequency of the categories of the morphological facial index in the 19 year old female and 20 year old male university students investigated between 1976–1985 according to their place of birth**

Categories of the morphological facial index	Female students						Male students					
	Born in Budapest[1]		Born out of Budapest[2]		Altogether		Born in Budapest[1]		Born out of Budapest[2]		Altogether	
	n	%	n	%	n	%	n	%	n	%	n	%
Euryprosop	159	24.6	261	35.3	420	30.3	1074	39.1	1975	47.7	3049	44.3
Mesoprosop	232	36.0	262	35.4	494	35.6	836	30.4	1267	30.6	2103	30.5
Leptoprosop	254	39.4	218	29.4	472	34.0	839	30.5	903	21.7	1742	25.3
Total	645	100.0	741	100.1	1386	99.9	2749	100.0	4145	100.0	6894	100.1

[1, 2] Differences between the birth-places are significant at the $P < .001$ level of probability *in all cases*

Table 5. **Head length (M.1), head breadth (M.3), bizygomatic diameter (M.6), morphological facial height (M.18), cephalic index (M.3:1) and morphological facial index (M.18:6) of the 19 year old female and the 20 year old male university students investigated between 1976–1985 according to the educational level of their fathers**

Martin's No.	Female students							Male students						
	Elementary[1] (n = 303)		Secondary[2] (n = 317)		Coll./Uni.[3] (n = 742)			Elementary[1] (n = 2103)		Secondary[2] (n = 1711)		Coll./Uni.[3] (n = 3027)		
	M	SD	M	SD	M	SD	P	M	SD	M	SD	M	SD	P
M.1	180.06	5.89	181.19	5.96	181.90	6.64	+	189.47	6.33	190.55	6.34	191.43	6.87	+
M.3	153.53	4.98	151.96	4.97	150.97	5.68	+	160.19	5.73	159.01	5.79	157.47	6.01	+
M.6	136.77	4.85	135.62	4.50	134.95	4.81	+	143.85	5.10	143.11	4.95	142.28	5.03	+
M.18	111.90	5.77	113.19	5.76	113.02	5.66	+	120.45	6.39	121.33	6.29	121.41	6.40	+
M.3:1	85.35	3.83	83.97	4.02	83.11	4.48	+	84.63	3.72	83.54	4.03	82.37	4.30	+
M.18:6	81.88	4.47	83.52	4.55	83.82	4.47	+	83.80	4.80	84.85	4.70	85.40	4.81	+

[1, 2, 3] Differences according to educational level of the fathers are significant at the $P < .001$ level of probability

Table 6. **The frequency of the categories of the cephalic index in the 19 year old female and 20 year old male university students investigated between 1976–1985 according to the educational level of their fathers**

Categories of the cephalic index	Female students								Male students							
	Elementary[1]		Secondary[2]		Coll./Uni.[3]		Altogether		Elementary[1]		Secondary[2]		Coll./Uni.[3]		Altogether	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Dolichocephalic	7	2.3	11	3.5	64	8.6	82	6.0	31	1.5	57	3.3	194	6.4	282	4.1
Mesocephalic	49	16.1	97	30.6	241	32.3	387	28.3	316	15.0	397	23.1	985	32.4	1698	24.7
Brachycephalic	248	81.6	209	66.0	440	59.0	897	65.6	1761	83.5	1261	73.4	1860	61.1	4882	77.1
Total	304	100.0	317	100.1	745	99.9	1366	99.9	2108	100.0	1715	99.8	3039	99.9	6862	99.9

[1, 2, 3] Differences according to educational level of the fathers are significant at the $P < .001$ level of probability

Table 7. **The frequency of the categories of the morphological facial index in the 19 year old female and 20 year old male university students investigated between 1976–1985 according to the educational level of their fathers**

Categories of the morphological facial index	Female students								Male students							
	Elementary[1]		Secondary[2]		Coll./Uni.[3]		Altogether		Elementary[1]		Secondary[2]		Coll./Uni.[3]		Altogether	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Euryprosop	137	45.1	87	27.4	184	24.7	408	29.9	1085	51.5	758	44.2	1185	39.0	3028	44.1
Mesoprosop	90	29.6	114	36.0	283	38.0	487	35.7	604	28.7	530	30.9	959	31.6	2093	30.5
Leptoprosop	77	25.3	116	36.5	278	37.3	471	34.5	419	19.8	427	24.9	895	29.5	1741	25.3
Total	304	100.0	317	99.9	745	100.0	1366	100.1	2108	100.0	1715	100.0	3039	100.1	6862	99.9

[1, 2, 3] Differences according to educational level of the fathers are significant at the P < .001 level of probability

Discussion

Our data show characteristic differences in the head measurements of the Hungarian university students according to the investigated two socioeconomic factors. The head and face of the students born in Budapest or having father with higher educational level are longer, respectively higher and narrower, than those of the students born out of Budapest or having father with elementary or secondary schooling. The majority of these differences are significant.

The question is the reason of these differences. Our opinion is that these phenomena are caused by multiple, but intercorrelated factors, which contain not only biological, but selective cultural factors, too.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 26 July, 1991.

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Anthrop. Közl. *33;* 55–64. (1991)

NEWBORN'S DEVELOPMENT BY SOCIODEMOGRAPHIC FACTORS IN A REPRESENTATIVE SURVEY

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Abstract: *Birth weight and duration of pregnancy of about 8000 live births have been worked up in the connection with some social and demographic factors. It is well known that birth weight and duration of pregnancy are influenced by healt, social and demographic conditions of mothers. In this paper, however, the newborn's development is focussed, which measures the corresponding of birth weight to gestational age. The main conclusion is that biological insuffiencies result shorter duration of pregnancies rather than dismaturities, while disadvantageous social background has a considerable effect on the birth weight as well as the development of babies. In this respect education of mothers has the most significant influence on the newborns' parameters.*

Key words: *Newborns; Sociodemographic factors; Low birth weight; Small for gestational age; Appropriate for gestational age; Large for gestational age*

Introduction

In Hungary the average number of children per family has been so low for decades that it does not ensure the replacement of the population. This can be attributed to the fact that the number of live births decreased from year to year – especially since the last third of the 1970s – and both the perinatal and infant mortality rate are very high on an international scale. Though in the recent past both of them improved almost uniformly, this decrease does still not the desired extent. The unfavourable high infant mortality can be ascribed, first of all, to the high proportion of children of low birth weight and of small for gestational age.

As the earlier results of this research have proved, development by birth weight has an influence on the children's weight and height development until their age of 6 years at least.

The aim of the present paper is to point at some criteria which have a significant effect on the children's developoment regarding their gestational age and birth weight together.

Material and Methods

The data of this paper relating to about 8000 live births come from the "Health and demographic survey of pregnant women and infants" started in 1979 (Joubert, Gárdos 1991). Regarding the Hungarian standard for birth weight (Joubert 1983), newborn constitute three groups according to their gestational age and birth weight: SGA (birth weight is lower than the 10th percentile values relating to the actual gestational age), AGA (birth weight is between the 10th and 90th percentile values) and LGA (birth weight is above the 90th percentile value) (Battaglia, Lubchenco 1967). Duration of pregnancy, birth weight have been investigated in the connection with the mothers' age, previous obstetrical events, educational level, economic activity, as well as with that if the pregnancy was wanted and planned, if mothers needed intensive prenatal care, and with mothers' smoking habit before and during pregnancy. The significant differences in the values, of average birth weight has been established using T-test, and inequalities among several distributions according to the development of babies have been evaluated by χ^2-test.

Results

In the age group of 20–24 year old women 91 per cent of children were born in term, that is gestational age was at least 37 weeks. Considering birth weight this age interval is enlarged with the next five years, and what is more the 25–29 year old mothers' offspring are the biggest, their average birth weight exceeds 3200 grams. Birth weight of the 82 per cent of babies born to 20–24 year old mothers were AGA. Among both younger and older women's infants the ratio of AGA children is lower, however in the younger age groups the proportion of SGA is higher, while at older ages mothers have LGA babies more frequently (*Fig. 1*).

Depending on the *age of women* not only the newborn's distribution varies according to their development but the *average birth weight* in the three categories alters as well. Birth weight of AGA and LGA babies is the highest among the infants born to 25–29 year old women, while it is the lowest among those of mothers under 20. The difference

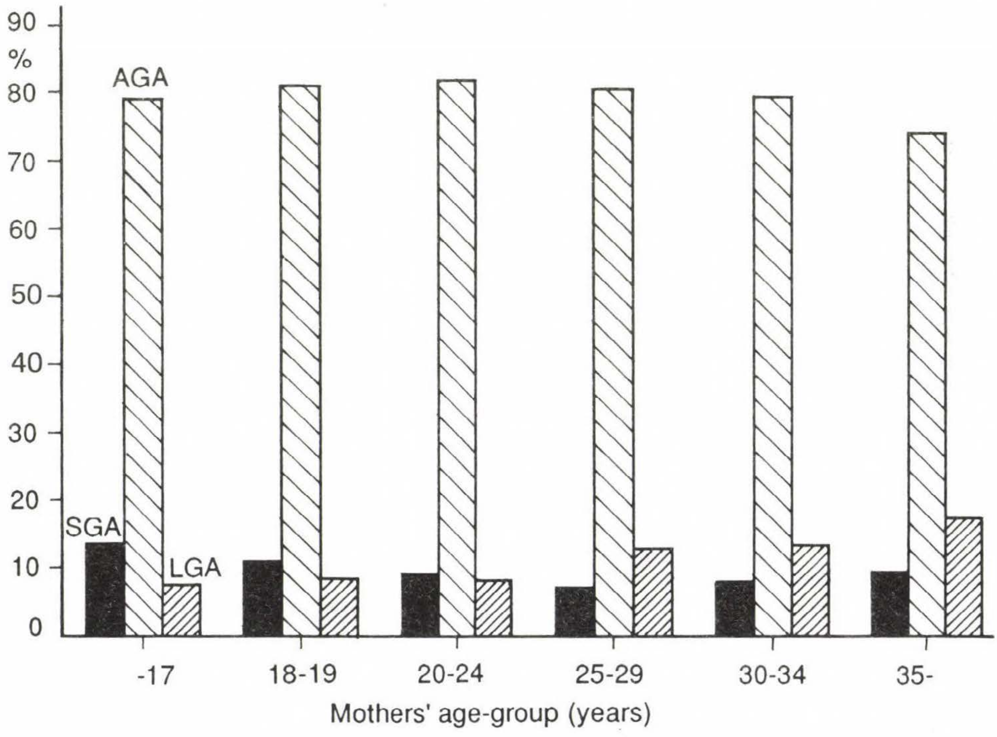

Fig. 1: **Distribution of newborns by development and mothers' age-group**

is highly significant between the average birth weight of children born to 18–19 and 25–29 year old mothers. Rising mothers' age the average birth weight standardized on the distribution of the previous obstetrical events gradually increases. In spite of the highest proportion of AGA children among mothers who had had one or two pregnancies, but not all of them ended in live births, the ratio of low–birth–weight babies is the lowest among the mothers who had had also one or two pregnancies before the investigated pregnancy, but all of them ended in live births (*Fig. 2* and *3*).

Social, cultural sorroundings can be approached by the *mother's educational level* at the best (e.g. Eiben 1989). Women of the lowest educational attainment are in a significantly lower position in the both respect of gestational age and birth weight. The ratio of the SGA infants is 2–3 times higher than in the any other group by school years completed (*Fig. 4*). The proportion of low–birth–weight babies is 19 per cent vs. the 8 per cent of the whole sample. Even in the category of women completed 8 years the ratio of low birth weight infants does not reach the half of that of the former one. Among the children of mothers of at least 8 grades the percentage of LGA ones is equally about 11, there is only difference relating to the distribution between AGA and LGA groups. Elevating the number of years completed the average birth weight increases in all the three categories of the development (*Fig. 5*).

Rising the school years completed by women the ratio of *not wanted children* considerably increases. This percentage is 36 among the mothers of the lowest educational attainment, while it is 3 among those who had at least 13 years completed. The 11 per cent of not wanted children did not reach the 2500 gram birth weight, and the proportion of SGA babies was the same. Although the ratio of LGA infants is the highest, the average birth weight of LGA children is the lowest here (*Fig. 6*).

While among *active and inactive women* the ratio of those having 7 years completed at most is about 2 per cent, this proportion of dependents is near to 1/3, and a further 40 per cent have 8 grades. In this latter group only 2 per cent of women had no previous live birth. The proportion of SGA babies is the lowest (7 per cent) and that of LGA infants is the highest (24 per cent) among inactive mothers vs. the dependent women where the ratio of SGA offspring is two timese higher. The average birth weight of dependents' babies is much lower in all of the three development categories, even in the LGA group: the differences is 300 grams (*Fig. 7*).

There is an opportunity to compare the significance of the *health and social background*, respectively, if gestational age and birth weight is investigated by the reason for *intensive prenatal care*. More than half of the women included into the sample needed intensive prenatal care immediately before the end of pregnancy. 90 per cent of them had "only" some health reasons, 5 per cent had "only" some social reasons, and 5 per cent left had both of them. Women only socially endangered are the most likely to have an SGA offspring (19 per cent) 2.5 times more frequently than among those who did not need intensive prenatal care, and more than 2 times than among women whose social background was satisfactory, but they or their foetus had certain health risks (*Fig. 8*). The ratio of low birth weight babies here is near three times higher comparing to those who were not endangered, what is more, in relation to the mothers who had only health risks, the low–birth– weight ratio is only 50 per cent more than in the latter group. Women endangered by social and health reasons as well have doubled

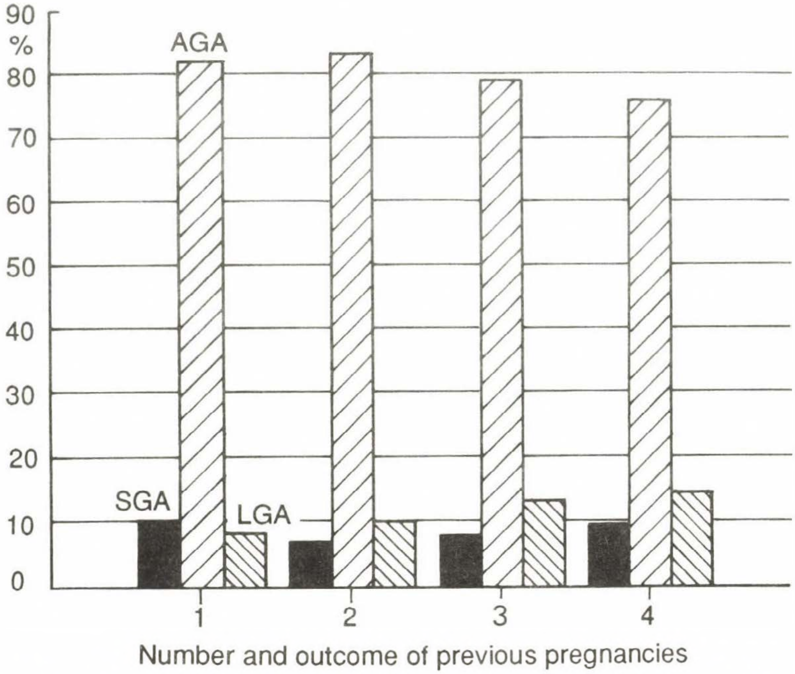

Fig. 2: Distribution of newborns by development and the number and outcome of previous pregnancies (1 = 1st pregnancy; 2 = 2nd or 3rd pregnancy, not only live births; 3 = 2nd or 3rd pregnancy, only live births; 4 = min. 4th pregnancy)

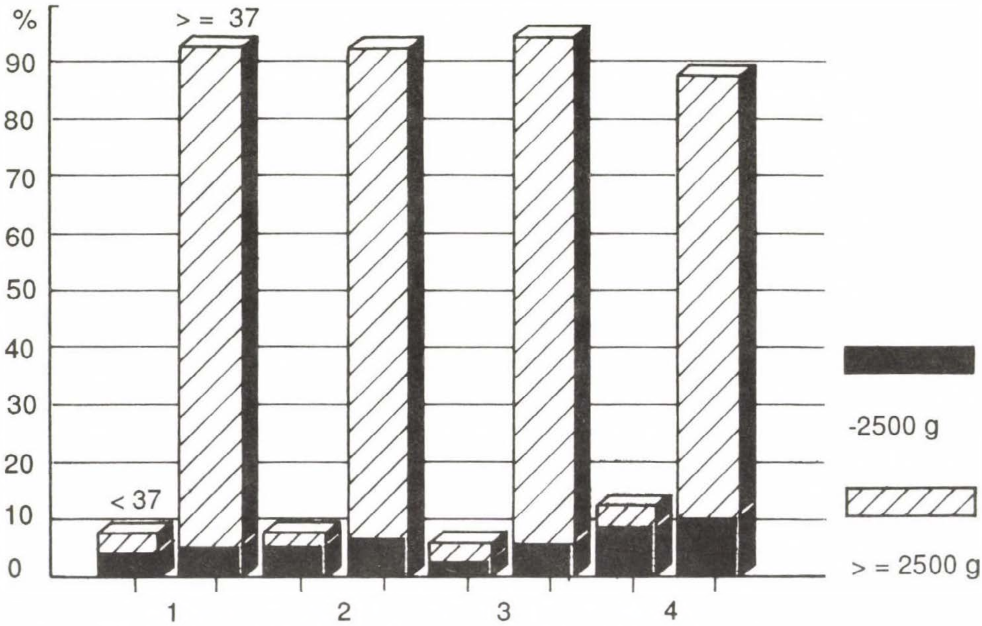

Fig. 3: Distribution of newborns by gestational age, birth weight and the number and outcome of previous pregnancies (for symbols see Fig. 2)

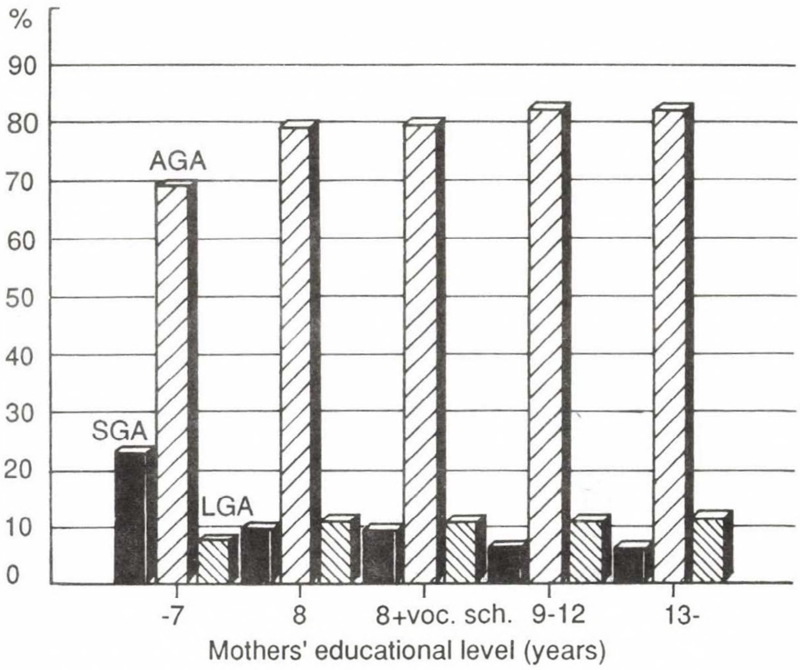

Fig. 4: Distribution of newborns by development and mothers' educational level

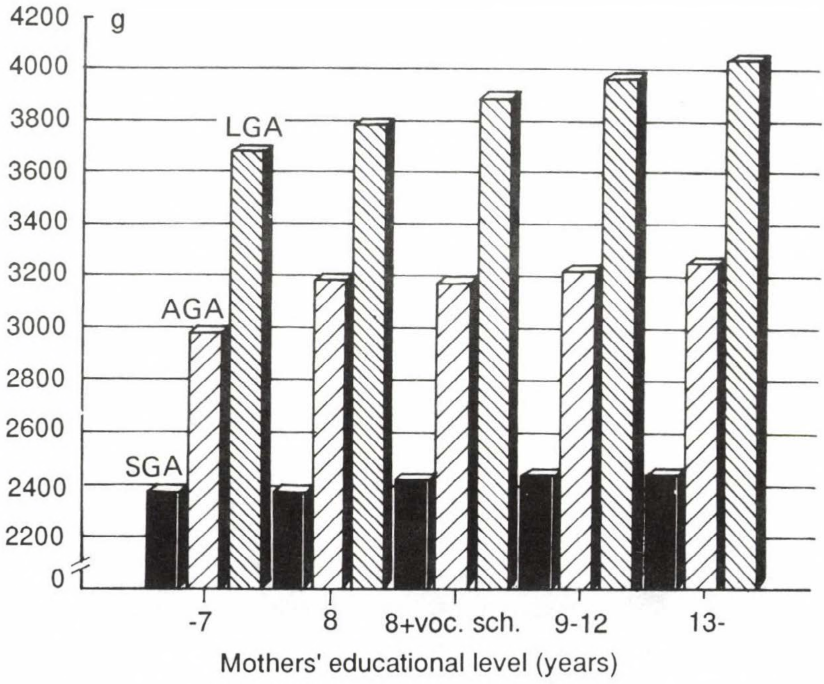

Fig. 5: Average birth weight by mothers' educational level and newborns' development by birth weight

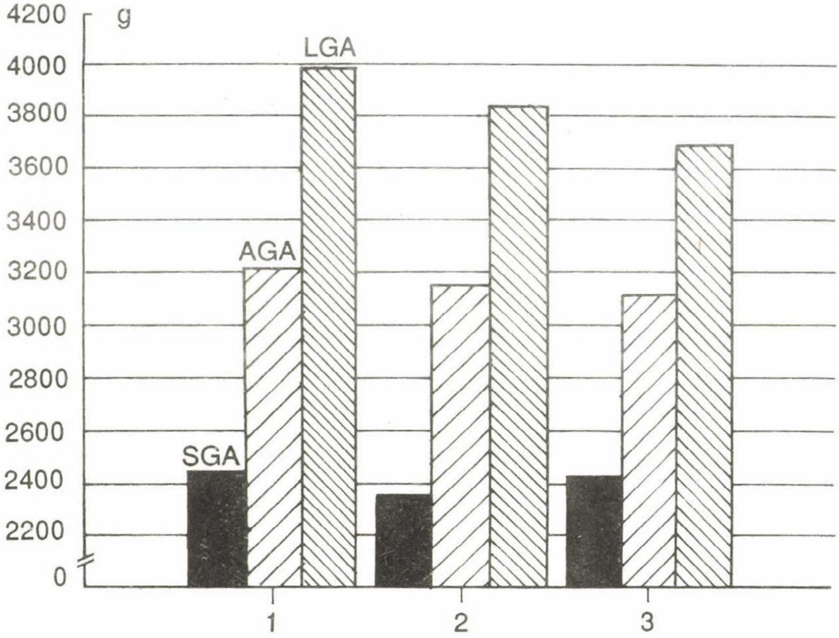

Fig. 6: Average birth weight by that if pregnancy was wanted and planned and newborns' development (1 = wanted, planned; 2 = wanted, not planned; 3 = not wanted)

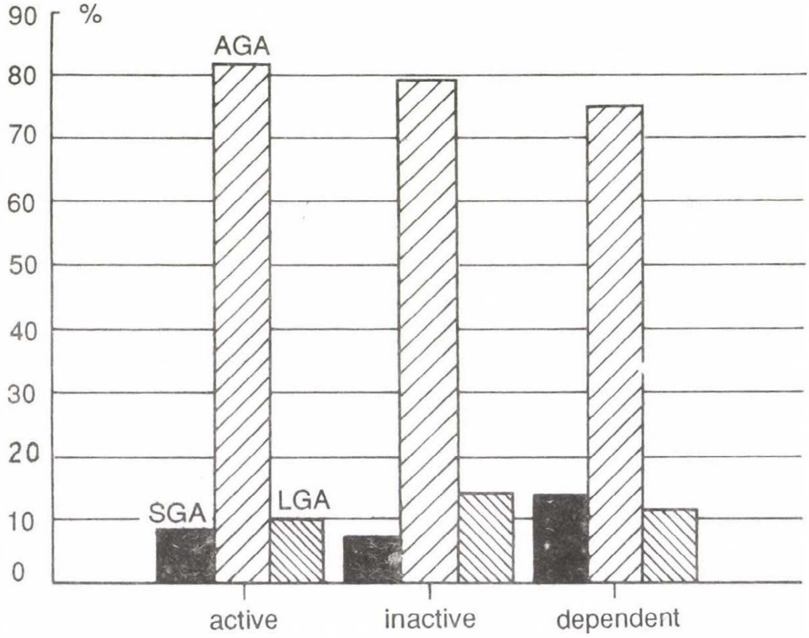

Fig. 7: Distribution of newborns by development and mothers' economic activity

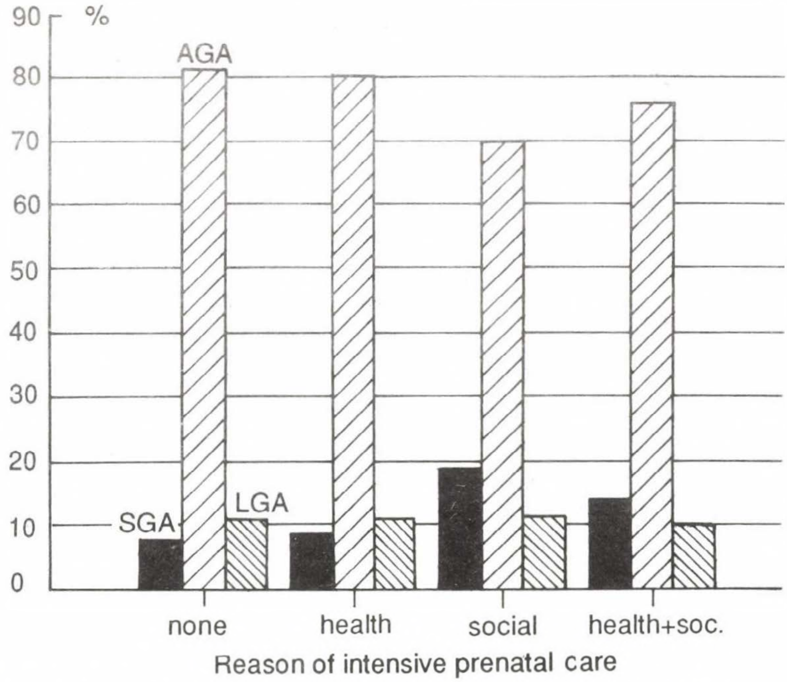

Fig. 8: Distribution of newborns by development and the reason for intensive prenatal care

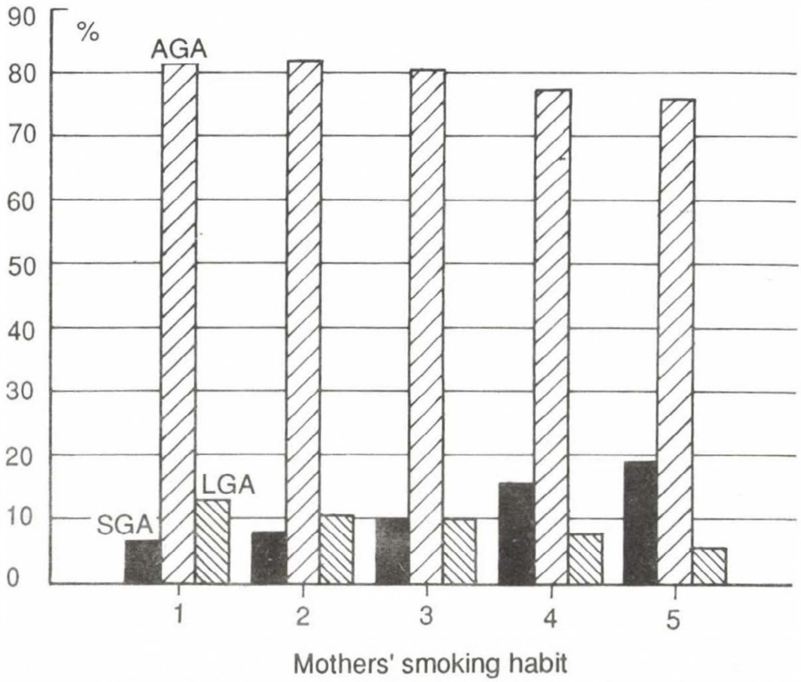

Fig. 9: Distribution of newborns by development and mothers' smoking habit
(1 = no smokers; 2 = smokers till pregnancy; 3 = smokers till the first prenatal care; 4 = smokers till the 20th week of pregnancy; 5 = smokers till the end of pregnancy)

risk and this fact deteriorates the parameters of infants in a certain relation. The proportion of pre-term and low–birth–weight babies, respectively, is the highest here, though, the ratio of AGA offspring is 10 per cent higher than among women of only social risk.

It is well known fact that *smoking during pregnancy* endangers the development of foetus. The proportion of SGA infants is the lowest, hardly more than 6 per cent, among women who had not smoked either before pregnancy. Rising the intensity of smoking it is gradually increasing to 19 per cent and the proportion of AGA and LGA offspring is decreasing in a parallel way (*Fig. 9*). Increasing the duration of smoking average birth weight is diminishing in all the three categories. However in this research it could be stated that smokers who had not smoked more than 20 cigarettes a day before pregnancy and they kicked up smoking about the time of conception have as high chance as the non smokers to give an in–term–birth. However, if she gives up smoking after about the 10th week of pregnancy it leaves its mark on the development of her child. Cigarettes smoked by mother during pregnancy significantly decrease the birth weight of infants as well, still the mothers giving up smoking before the 27th week of pregnancy can prevent her child from further injury (*Fig. 10*).

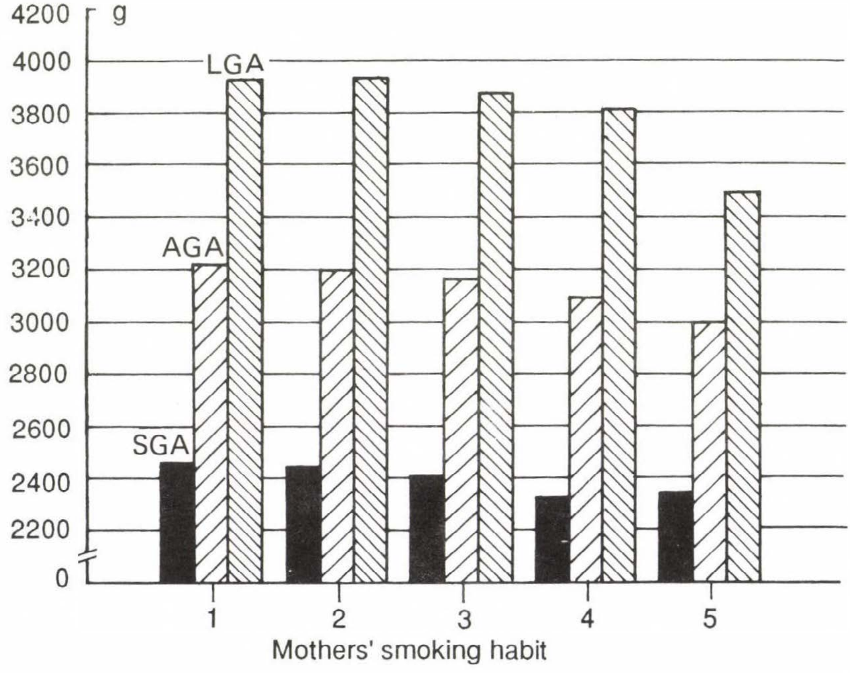

Fig. 10: Averae birth weight by mothers' smoking habit and newborns' development (for symbols see Fig. 9).

Discussion

Generally it can be stated that in an average group of females the unfavourable social background has the most considerable damage on the outcome of pregnancy (Gárdos 1982, Gárdos, Joubert 1990), especially in the relation of birth weight and the development of newborns. Duration of pregnancy is mostly influenced by biological factors. In consequence of the different determination of birth weight and duration of pregnancy, the low educational, cultural level, adverse attitude to the child, etc. go with insufficient development of children rather than with preterm gestational age.

It is supported by the fact that, although, in the connection with the mother's age referring to the duration of pregnancy it is generally known that 20–24 year old mothers have the most favourable conditions for giving a birth (Demographic Yearbooks of the CSO) has been proved in this research too, the 25–29 year old mothers' children are still the biggest and in this age group the proportion of LGA habies is higher.

It can be generally stated, that the number of previous pregnancies and live births among them is more important than the age of mothers. Women having 1–2 previous pregnancies, but at least one of them ended in either stillbirth or spontaneous or induced abortion might have primary or secondary obstetrical defect, however, this resuts a low–birth–weight baby because of premature delivery rather than because of dismaturity. It is supported by the fact that not only the proportion of SGA group is the lowest here, but among the preterm babies the percentage of those under 2500 grams is the smallest as well. This calls the attention to the phenomenon mentioned earlier that the harmful factors connected with biological origin shorten duration of pregnancy rather than influence development by birth weight. Those who had at least three pregnancies earlier constitute a separate group, and their disadvantageous status is generally caused rather by their adverse social, cultural background.

Mothers' educational attainment generally has a close correlation with their social background, life style, health and hygiene knowledge, housing, etc. In extreme situations the lack of education is an obstacle of the social integration. All of them can prevent women to use the required contraception method, to recognize a pregnancy at an early phase, to use prenatal care in time and further, they are likely to have a very risky prenatal behaviour (Casper, Hogan 1990). The low educational level causes three types of attacks against pregnancy and foetus: 1. the ratio of in–term–babies is reduced; 2. the proportion of low–birth–weight infants is higher and 3. the relationship between these two parameters refers to that much more intrauterine retarded children are born here. The significance of the educational level is highlighted by the fact that only 12 per cent of babies born from a pregnancy during which the mother had bleeding or contractions weighed under 2500 grams at birth, and this ratio is considerable lower than the value experienced at infants whose mother had had neither bleeding nor contractions but had only 7 school years at most.

The fact if the pregnancy was wanted and planned – on the basis of its relationship with other investigated variables – reflects the cultural, social background of the family and surroundings rather than the mother's age or previous obstetrical events. Similarly, the mother's economic activity, marital status, cultural level, even the type of her living pace relate to a sort of way of life, and this is reflected by the parameters of pregnancy.

In Hungary, generally, those women do not have a job out of their home whose educational level is lower and living conditions are unfavorable. It can be mostly explained by that the minors are highly represented here (17 per cent) and the ratio of the 18–19 year old mothers is similar, however among economically active women the ratio of those under 20 is hasrdly above 10 per cent and among inactive it does not reach 5 per cent. The cultural, social background going with the young age and low educational attainment is enough for dependents to have the shortest pregnancies, and two times higher LBW ratio than among the inactive mothers who were mostly on children's care leave at the time of the data collection.

Investigating the reasons for intensive prenatal care our hypothesis referring to the importance of social background is supported, although, these are established by the obstetricians and the district nurses. Considering both of gestational age and birth weight social problems have more significance in this respect. Women endangered by both of health and social reason have the most LBW babies partly because of the highest proportion of prematurity, partly because of dismaturity.

It can be proved that smoking – in addition to its direct effect – transmits other negative characters of mothers referring to their cultural level, life style, etc. This is especially true for women who smoke a lot and do not kick up smoking at an early phase of pregnancy. The lower the mother's educational attainment, the higher the probability of her smoking during pregnancy and the more the number of daily cigarettes is. It is sure that the women who does not continue smoking from the time of about conception prepares for the arrival of her child, and this may be the explanation for the phenomena that in these cases the effect of early smoking is eliminated.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 31 July, 1991.

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Anthrop. Közl. *33*; 65–71. (1991)

ATTAINED HEIGHT OF BOYS AT PUBERTY AS A REFLECTION OF SOCIAL DIFFERENCES

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Abstract: *Attained height at puberty has been used as a measure of growth status of boys in two cities; Warsaw and Wrocław. Important source of variation in growth has turned out to be social factors such as parental education and occupation, the origin of parents, number of children per family etc. The distance in height of the groups of boys from extreme social categories has appeared to be the same in Warsaw and in Wrocław.*

Key words: *Boys' puberty; Socio-economic status; Wrocław boys*

Introduction

This is to report on a study performed in Wrocław as a parallel investigation to the one carried out by Bielicki and Charzewski in Warsaw. The aim of the work is to assess the development of boys during the period of the most variable phase of their growth in relation to the socio-economic situation of their families.

Many conclusions of our work agree with the ones known from the literature (Bielicki 1986, Bielicki et al. 1986, Brzezinski 1964, Charzewski 1981, Chrzastek-Spruch et al. 1984, Goldstein 1971, Mascie-Taylor and Boldsen 1985, Milicer 1968, Piasecki and Panek 1982, Tanner 1989, Waliszko 1988), though some are new.

In studying the secular trend of human growth one of the mostly used traits is the age of girls at menarche. The lack of such a precise sign of maturation in boys causes that the data for boys are usually taken during their physical examination connected with the military service. The gap of about 8 years of age between boys and girls at the moment when the data are collected may bias the results inferred. Changing socio-economic conditions of families of similar characteristics at the time of the birth of a child might be significant enough to obscure the picture. If a study like ours would be repeated in some eight years, this point could be clarified and so it would also contribute toward a better estimation of the magnitude of the secular trend in children maturation in boys and in girls.

Material

All boys from the last two grades from all elementary schools in Wrocław, 6969 in number, have been asked to fill up a questionnaire concerning their families socio-economic conditions (cf. *table 2*)

Upon collecting the filled up questionnaires 6689 boys were measured by an anthropologist, the remaining 280 boys were absent. The data concerning their height, weight, eye color, facial hair and voice development were taken. The height was measured by means of an anthropometer up to the nearest 0.1 cm.

From the group of 6689 boys whose measurements have been collected, 742 boys of divorced parents, of single parents and orphans as well as 460 boys either younger than 13.30 (the ones who have started school earlier) or older than 15.29 (the ones who have repeated a class) have been eliminated from further study.

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Table 1. **Mean height of boys (cm) aged 13.30–15.29 attendig Wrocław schools in 1987**

Age	N	M	SD
13.30 – 13.79	1319	160.85	8.40
13.80 – 14.29	1470	163.99	8.46
14.30 – 14.79	1396	167.13	7.94
14.80 – 15.29	1302	170.24	7.57
13.30 – 15.29	5487	165.59	8.82

Table 2. **Categories of socio-economic status characteristics**

Education of father or mother	1. University 2. High school 3. Vocational 4. Elementary
Number of children	1. The only child 2. 1 sib 3. 2 siblings 4. 3 + siblings
Dwelling conditions	1. x–1.0 person per room 2. 1.1–1.5 person per room 3. 1.6–2.5 person per room 4. 2.6–x person per room
Consumer goods possessed by a family out of six enumerated	1. Washing machine 2. Colour TV 3. Deep freeze 4. Video 5. Car 6. Summer cottage
Origin of father or mother	1. City 2. Town 3. Village
Grandfathers occupation	1. White collar 2. Blue collar 3. Farmer
Occupation of parents, father & mother (if occupation of mother is ot specified it means that mother was considered independent of her occupation)	1. Manager 2. Professional & professional 3. Engineer & professional 4. Professional & technician 5. Technician & technician 6. Army or police officer 7. Soldier or policeman 8. Worker & technician 9. Worker & worker or housewife 10. Worker 11. Unskilled worker 12. Small businessman 13. Father disabled or on pension

Method

In the pressent study we are concerned only with the height of the boys, leaving aside all other measurements. For detailes concerning other measurements see Hulanicka (1990). The boys are divided into four groups with respect to age *(Table 1)*. The groups are almost equal in size. The mean height computed for each group increases linearly with age, the standard deviation being quite high, and only slightly smaller in the group of eldest boys. This show, as expected, the diversity of the heights of the boys in the age bracket considered. On the other hand, the socio-economical status of the boy's family has generally remained the same during the period of two years. Thus comparing the mean height of boys with one socio-economic characteristic in one of the four groups leads to the same results as doing the same for the mean of the whole sample (*Table 2*).

As a matter of fact, what we did is this: first we have compared the means in each of the four groups, and then we have computed the mean of the means: this is why in the last column M is the mean of the means in groups. The choice of this procedure has been also induced by the fact that such a procedure had been applied by Charzewski and Bielicki (1990).

Results and Discussion

Dependence of the mean height of boys grouped according to a single factor such as parents education, number of children in a family, dwelling conditions, number of comsumer goods owned by a family, occupation of parents, occupation of both grandparents is shown in *tables 3–8*.

Table 3. **Mean height of boys (cm) aged 13.30–15.29 years by father's and mother's education**

	Education	N	Height	Mean age
Father's	University	1324	166.74	14.24
	High school	1857	165.77	14.28
	Vocational	1715	164.81	14.33
	Elementary	548	164.22	14.33
Mother's	University	933	167.21	14.22
	High school	2516	165.85	14.28
	Vocational	1299	164.85	14.33
	Elementary	700	163.62	14.33

Table 4. **Mean height of boys (cm) aged 13.30–15.29 years by the number of children in family**

Number of children	N	Height	Mean age
1	934	166.33	14.26
2	3188	165.69	14.27
3	959	164.86	14.34
4+	371	164.16	14.38

Table 5. **Mean height of boys (cm) aged 13.30–15.29 years by dwelling conditions of family**

Dwelling conditions	N	Height	Mean age
1	1174	166.30	14.27
2	2275	165.65	14.29
3	1658	165.17	14.29
4	365	164.13	14.31

Table 6. **Mean height of boys (cm) aged 13.30–15.29 years by the number of consumer goods owned by a family**

Number of goods	N	Height	Mean age
6	556	167.45	14.39
5	233	166.67	14.28
4	1161	166.22	14.25
3	1331	165.88	14.29
2	1277	165.30	14.31
1	893	164.71	14.27

Table 7. **Mean height of boys (cm) from Wrocław aged 13.30–15.29 by occupation of parents**

Parental occupation	N	Height
Manager	135	168.4
Professional & professional	237	168.4
Engiheer & professional	246	168.8
Professional & technician	349	167.0
Technician & technician	560	166.9
Army or police officer	139	167.9
Solider or policeman	228	166.2
Worker & technician	574	167.3
Worker & worker or husewife	823	165.4
Worker	2348	166.0
Worker unskilled	622	166.8
Father disabled or on pension	380	165.9

Table 8. **Mean height of boys (cm) aged 13.30–15.29 years by occupation of their grandfathers (mother's father and father's father)**

Both grandfathers	N	Height	Mean age
White collar	495	167.00	14.25
Blue collar	1341	165.08	14.29
Farmers	741	164.67	14.33

Table 9 presents the relation of the height of the boys to the length of time after migration of the mother from a rural area to town. The percentage of women who moved from a village to Wrocław is high: around 33% in our sample. We see that the average height of the boys increases linearly with the number of years that the mothers have lived in the city. No dependence of the average height of the boys on the time of the migration of fathers to city and has been revealed.

Table 9. **Mean height of boys (cm) aged 13.30–15.29 years according to the years prior to migration of their mothers from rural areas to Wrocław (years prior to migration = birth year of examined boy–calendar year of immigration of mother)**

Years prior immigration of mother	N	Height	Mean age
x – 15.00	175	166.41	14.35
14.99 – 10.00	308	165.79	14.33
9.99 – 5.00	425	165.74	14.34
4.99 – 0.01	549	164.94	14.35
0 – x	357	164.74	14.32

Table 10 relates the average height of the boys to two factors: affluence of the family and education of the parents. By our definition, an *affluent* family is one with at most two children and which possesses at least three of the six consumer items shown in table 2, in a *poor* family there are at least three children and no more than two consumer items listed. We see that affluence of a family is a negligible factor in comparison with education of the parents.

Table 10. **Mean height of boys (cm) aged 13.30–15.29 years from "poor" and "affluent" families by parental education**

Parental education	Height					
	Affluent families			Poor families		
	N	M	Age	N	M	Age
University	472	167.12	14.20	43	167.44	14.23
High school	608	165.93	14.28	96	165.09	14.40
Vocational	249	165.86	14.43	116	165.34	14.53
Elementary	37	163.16	14.35	90	164.61	14.58

Due to technical reasons only the average height of boys of age 13.50–14.49 from Wrocław and Warsaw has been compared. *Table 11* presents the comparison with respect to education of the parents as *table 12* present this comparison in relation to occupation of the parents. In every group the boys from Warsaw are taller.

Table 11. **Mean height of boys (cm) aged 13.50–14.49 living in Wrocław and in Warsaw by parental education (data on boys from Warsaw from Charzewski and Bielicki, 1990)**

Parental education category	Wrocław N	Wrocław M	Warszawa N	Warszawa M	d
University	393	165.9	771	166.5	+ 0.6
High school	426	164.0	1050	165.1	+ 1.1
Vocational	391	162.6	345	163.9	+ 1.3
Elementary	178	161.9	126	162.5	+ 0.6
Difference between categories University and Elementary		4.0		4.0	

Table 12. **Mean height of boys (cm) aged 13.50–14.49 years by occupation of parents (data on boys from Warsaw from Charzewski and Bielicki, 1990)**

Parental category	Wrocław N	Wrocław M	Warszawa N	Warszawa M	d
Manager	67	165.2	60	167.5	+ 2.3
Professional & professional	115	165.5	235	166.2	+ 0.7
Engineer & professional	130	166.1	247	166.4	+ 0.6
Professional & technician	172	165.1	238	165.7	+ 0.6
Technician & technician	263	163.7	308	165.4	+ 1.7
Army or police officer	69	164.2	137	166.8	+ 2.6
Solider or policeman	126	163.0	106	164.6	+ 1.6
Worker & technician	270	164.5	323	165.6	+ 1.1
Worker worker or housewife	338	161.9	451	163.7	+ 1.8
Worker	1109	162.9	1347	164.3	+ 1.4
Unskilled worker	291	162.9	334	164.1	+ 1.2
Small businessman	166	163.4	232	164.6	+ 1.2
Father disabled or on pension	152	163.1	99	164.0	+ 0.9

Notice that the difference is the smallest in the groups of boys whose parents are highly trained professionals.

As mentioned above, the results are quite as expected: boys of affluent, well educated parents are significantly taller than those of poor, badly educated parents. However, education of the parents seems to be a much stronger factor influencing the height of a boy than the standard of living of the family. The "family tradition" seems to be of importance: better educated grandfather has usually a taller grandson, also the time of the migration of the mother from a rural area to the city is significantly related to the height of her son while no such relation to the time of the migration of the father to the city and the height of his son has been detected.

The results of Charzewski and Bielicki (1990), in the extent as they can be compared with ours, stress the influence of urbanization. The boys in Warsaw are taller than the ones of the same age in Wroclaw, the population in Warsaw having stronger urban tradition.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 2 August, 1991.

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Anthrop. Közl. 33; 73–80. (1991)

ON THE USEFULNESS OF INDICES FROM POSTCRANIAL BODY MEASUREMENTS IN CLASSIFICATION OF CONSTITUTIONAL COMPONENTS, ILLUSTRATED BY DATA OF THE "BRAUNSCHWEIG LONGITUDINAL STUDY"

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Abstract: *After studying available allometric literature and as a conclusion from our own investigations, we are convinced that the use of indices in comparing populations (not individuals) should be restricted to cases (1) of proven isometry or (2) where there is no significant correlation between the measurements pertinent to the index.*

Using data from the "Braunschweig Longitudinal Study", we shall demonstrate this inference for measurements which are relevant for classification of constitution.

The initial data in nearly all utilized pairs of measurements show highly significant correlations. However, these correlations are due chiefly to the influence of body height. After eliminating this influence by using regression the significant correlations between many of the body measurements were subsequently lost. This may make the use of indices justifiable, provided that the raw data were transformed in the appropriate manner.

Key words: *Population comparison; Constitution; Dependence of body measurements on standing height; Indices*

Introduction

In the allometric literature, discussions dating back to the sixties and seventies can be found which explain that a (median) index for comparing populations can be utilized only under certain conditions. In anthropology, however, the necessary consequences of this fact are still hardly taken into consideration when the proportions of different populations are being compared.

The use of an index is justified only in the case of two constellations where the proportions found in random samples are adequately described (*Fig. 1*).

(1) *Isometry* (see *Fig. 1b*): The first case is when both of the related body measurements (not dependent on height) are isometric, that is, when the line of regression through the cluster of data points shows a slope of 45 degrees; the regression coefficient $b = 1$. The median index adequately describes the relationship of measurement parameters, since the relationship of ΔY to ΔX is constantly equal to one ($\Delta Y : \Delta X = 1$) for all values of "X".

(2) *No correlations* (see *Fig. 1c*): In the second constellation, the utilized body measurements (not dependent on height) must show no significant correlation, i.e. (r) is approximately equal to zero ($r \approx 0$). Then, any measurement "X" within the population can belong to any measurement "Y", and the median index reflects this proportion in a random sample.

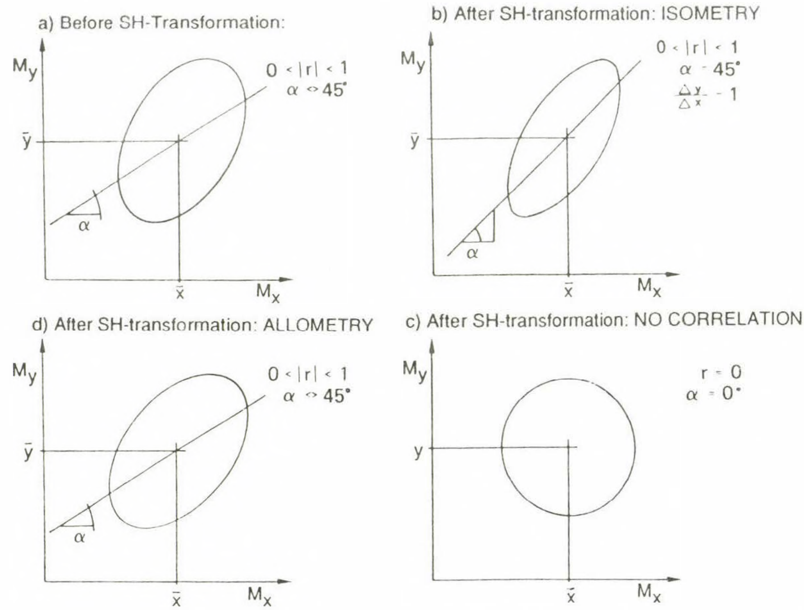

Fig. 1: (a) Raw data, i.e. Population before SH-transformation, (b) after SH-transformation: isometry; (c) after SH-transformation: no correlation; (d) after SH-transformation: allometry; r: correlation; α: slope; further explanation see text and Fig. 2.

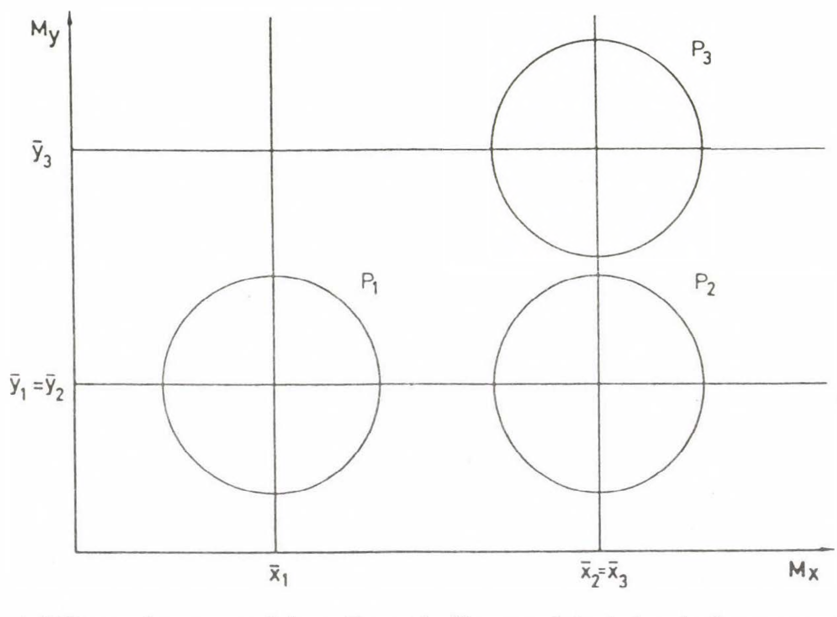

Fig. 2: Differences between populations without a significant correlation in the pair of measurements can be made true only when there is a significant difference between one or both means of the measurements. $P_{1,2,3}$: population 1–3; $\bar{x}$, $\bar{y}$: mean of the measurement; M_x, M_y: logarithms of the investigated body measurement

Figure 2 displays the comparison of populations, in which the investigated measurements have no correlation. We only find differences between those populations where there is a significant interval in mean value between at least one of the measurements (M_x or M_y).

Allometry (see *Fig. 1d*): If a combination of body measurements shows a significant correlation and a significant regression coefficient where (b) is not equal to one ($b \neq 1$), then regression from "Y" to "X" must be determined in order to compare the populations. In this case, it would not make any sense to use an index as the reference measurement, because it varies in accordance with "X". The index is therefore dependent on the measurement dimensions, which fulfills the definition of intraspecific allometry.

Because of the influence of height on the total body proportions and, thus, on constitution (see Schwidetzky 1974, May 1977a, May & Kurth 1977, Knußmann 1980, May 1990, Bitzan & May 1992), we considered the question of the reliability of comparison of populations when the individuals have different median heights. In 1985, May had already discussed a possible corrective measure.

According to Schwidetzky (1974), bodily structure or constitution is defined as the main proportions of the body, that is, the proportional relationship between the trunk and the extremities. These proportions, similar to those of the long bones, vary according to a person's height (see also May 1977a, May & Kurth 1977). By including allometric methods, May (1976, 1977a, 1977b, 1985) addressed the problem of standardizing body measurements and indices attempting to find a corresponding transformation which could eliminate the influence of height on (other) measurements and indices. The standing height (SH) computation formulas of Manouvrier (1892) and Breitinger (1937) are good examples of how the growth tendencies of different populations can be combined by means of the appropriate transformations (also see Bitzan 1984, Bitzan & May 1991). It now seems appropriate to transfer these ideas and results to index studies with indices used for evaluation of constitution.

Subjects and Method

Based on data taken from the "Braunschweig Longitudinal Study", we will demonstrate the effects of transformation of the individual measurement values on the measurements in question.

Study Group Autumn 1978: 919 boys with an average age of 11 years, 0.6 months (= 4034 days; i.e.: from 3573 to 5036 days, which equals 9 years, 9.4 months to 13 years, 9.5 months) and 883 girls with an mean age of 10 years, 11 months (= 3985.3 days; i.e.: from 3582 to 4889 days, which equals 9 years, 9.7 months to 13 years, 4.6 months). The raw data for each individual were transformed to the median age of random samples for males and females, respectively, by means of semi-logarithmic regression (Bitzan & May 1991). The body measurements of these now age-standardized children were then used as the raw data for our further computations.

By means of linear regression, the logarithms of all body measurements were then transformed into agreement with the logarithm-derived heights based on the median value of random samples. Due to limitations of space, we cannot go into the details of this technique right now, see Knaust (1979), May (1985) and May & Bitzan (1992), as well as to mathematical literature on the basics of regression analysis (like Weber 1980; Sachs 1978; Tabachnik & Fidell 1983).

According to current opinions, the postcranial body measurements discussed here (in conformity with Knußmann 1980, p. 189) are relevant to constitutional evaluation of an individual (*Table 1*).

Table 1. **Abbreviations and definitions of the body measurements used**

Abbr.	Measurement	Martin/Knußmann (1988) No.	Page
SH	standing height	1	259
SSH	suprasternal height	4	260
SYH	symphyseal height	6	260
BAB	biacromial breadth	35	263
THD	thoracic depth	37	264
BIB	bi-iliocristal breadth	40	264
THC	thoracic circumference	61	270
BW	body weight	71	273

While Knußmann (1980) placed heavy significance on the "standing height (SH)" with respect to the leptomorphic/pyknomorphic factor, we totally disregarded this measurement, since it comprises exactly the influence which we wish to eliminate when comparing populations of different sizes. One must also consider that the constitutional type is principally genetically determined. The standing height (SH), however, reaches different values, for example, due to acceleration of growth processes and many other non-genetic reasons.

Results

All 42 possible combinations of raw data displayed a highly significant correlation for both sexes ($p < 0.01$). Isometry was seen in only a few combinations (boys 9, girls 5).

After height transformation had been performed, the situation was greatly changed. Only 31 of the boys original 42 data pairs (girls 28 pairs) still showed relevant correlation. Isometry is merely found altogether for 5 combinations. THD : SSH, THC : SSH for both sexes, and THD : BW for boys. Entirely the last measurement pair shows a slope significantly different from zero. The median index would therefore be an appropriate reference measurement for an adequate, different population only if it possesses just this attribute.

As a first example see the boys thoracic depth (THD) to body weight (BW).

Isometry (corresponding with *Fig. 3*).

♂ THD : BW	Correlation (r)	Slope (b)	Intercept (a)
before transform.	0.6803^{s}	$1.0063^{n} = 45.2^{o}$	3.8273
95% confid. limits	0.5567 — 0.8040	43.1^{o} — 47.1^{o}	3.7426 — 3.9119
after transform.	0.6076^{s}	$1.1551^{n} = 49.1^{o}$	3.6479
95% confid. limits	0.4852 — 0.7301	46.67^{o} — 51.4^{o}	6.3437 — 6.6730

^{s} : Significant when $\alpha = 0.01$

^{n} : No significant difference to one, when $\alpha = 0.05$.

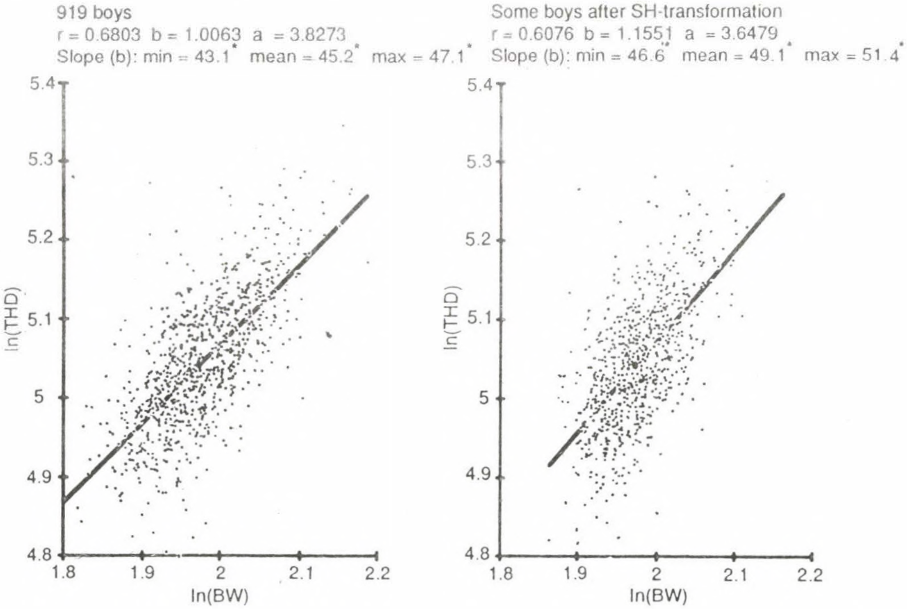

Fig. 3: 'Braunschweig Longitudinal Study': example for isometry in boys between THD and BW; r: correlation coefficient; b: slope; a: intercept; . (points): individual pair of measurements; ■ : sample mean $(\bar{x}, \bar{y})$; — : regression line.

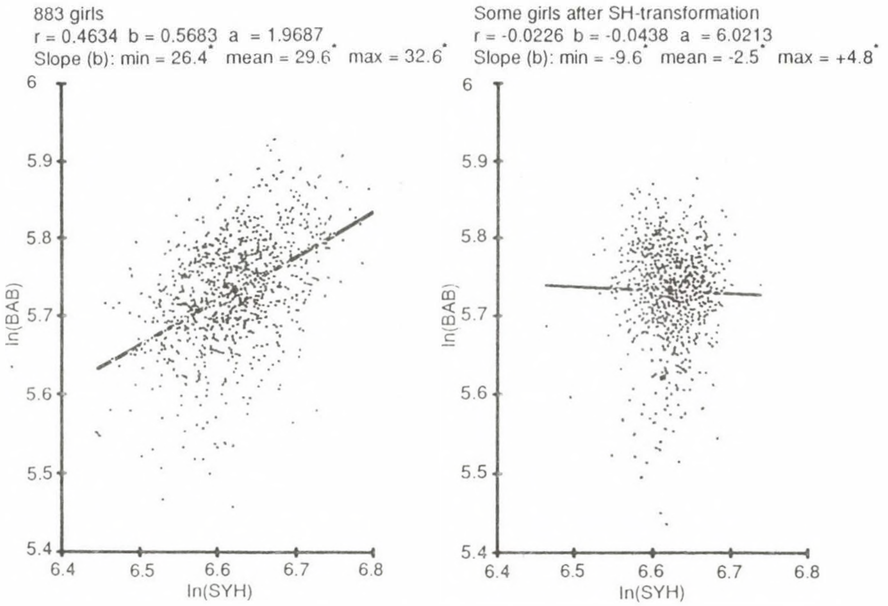

Fig. 4: 'Braunschweig Longitudinal Study': example for loss of correlation in girls between BAB and SYH: for further explanation see Fig. 3.

11 data combinations in boys thus no longer show a significant correlation after standing height (SH) transformation ($P > 0.05$; earlier value $p < 0.01$). This also applies to girls with respect to the same 11 data pairs as well as to 3 additional ones. As an example see *Fig. 4*, biacromial breadth (BAB) to symphyseal height (SYH) in girls.

Loss of correlation (corresponding with *Fig.* 4)

♀ **BAB : SYH**	**Correlation (r)**	**Slope (b)**	**Intercept (a)**
before transform.	0.4634^{s}	$0.5683 = 29.6^{os}$	1.9687
95% confid. limits	0.3380 — 0.5887	26.4° — 32.6°	1.4935 — 2.4440
after transform.	-0.0226^{n}	$-0.0438 = -2.5^{on}$	6.0213
95% confid. limits	-0.1401 — 0.0948	-9.7° — +4.8°	5.1755 — 6.8672

s : Significant r or $b \neq 1$, when $\alpha = 0.01$

n : No significant r or difference to one, when $\alpha = 0.05$.

With the exception of a few unclear results discussed in connection with isometry, the remainder of measurement data combinations show intraspecific allometry, even after the approximate exclusion of SH influence. For example, take the data pair thoracic depth (THD) to thoracic circumference (THC) of the boys (as shown in *Fig. 5*), which seemed unsuitable for use with indices. It requires the use of a regression equation.

Allometry (corresponding with *Fig.* 5)

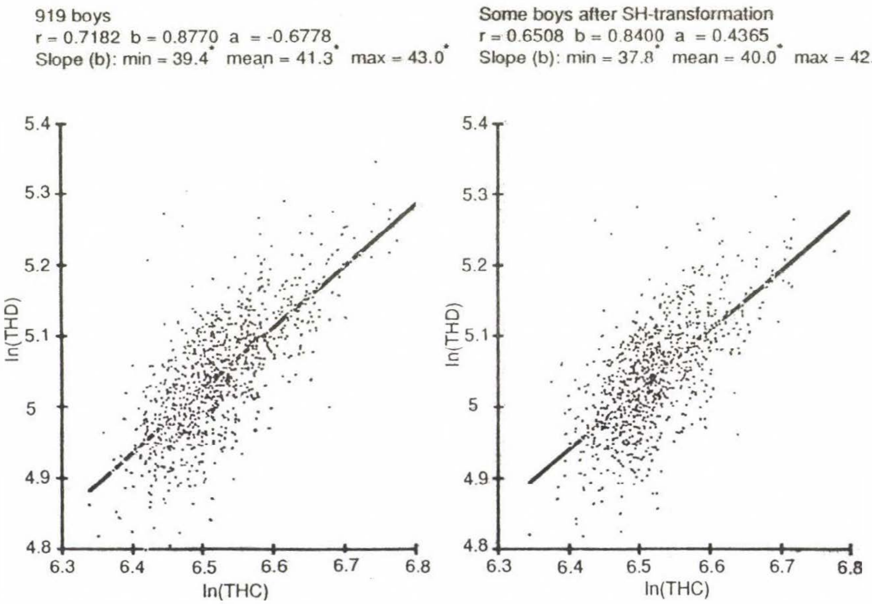

Fig. 5: "Braunschweig Longitudinal Study": example for isometry in boys between THD and THC: for further explanation see Fig. 3.

♂ THD : THC	Correlation (r)	Slope (b)	Intercept (a)
before transform.	0.7182^{s}	$0.8770 = 41.3^{o s}$	0.6778
95% confid. limits	0.6008 — 0.8356	39.4° — 43.0°	−1.0364 — −0.3193
after transform.	0.6508^{s}	$0.8400 = 40.0^{o s}$	−0.4365
95% confid. limits	0.5338 — 0.7679	37.8° — 42.1°	−0.8500 — −0.0229

^{s} : Significant r or b $\neq 1$, when $\alpha = 0.01$

These examples demonstrate that indices for evaluation of constitution can be utilized only in certain situations, since the measured bodily proportions do not automatically allow comparative statements on the constitutional type.

Acknowledgements: We thank B. Itter, U. Sauter and M. Sowa for producing the figures, S.O'Neal-Wandrey for translating the paper, and R. B. Eckhardt for helpful comments on the mannscript.

*

Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 23 July, 1991.

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Anthrop. Közl. *33;* 81–86. (1991)

PERCENTILES OF THE HUMAN GROWTH VELOCITY, BASED ON THE "BUDAPEST LONGITUDINAL GROWTH STUDY"

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Abstract: *In the "Budapest Longitudinal Growth Study" about four thousand children were investigated annually from 1970 (their year of birth) to 1988. Among various measurements several anthropometrical ones has been taken. We have chosen the 665 males and 739 females who had complete records of height to determine their growth velocities. First we fitted individual growth curves. The best fit could be achieved by the method of Bock and Thissen (triple logistic). Velocity curves has been determined by calculation of the derivatives of the growth curves at preassigned time points.*

The median growth velocity of boys reached its maximum of 7.5 cm/year at their age of 13, the minimum preceeding if being 4.8 (10). The same number of girls were 6.8 (11) and 5.2 (9), respectively (ages in brackets). Higher percentiles (90, 97) showed considerably greater differences between the maximum and preceeding minimum, lower ones (3, 10) showed much less difference, or didn't have any peak at all.

Key words: *Growth velocity; Budapest Longitudinal Growth Study.*

There are several advantages of investigating the same cohort longitudinally, as compared to cross-sectional studies. One of them is that not only can the general tendency of growth be described, which can also be seen using cross-sectional data, but its inter-individual variability as well. This can be shown by constructing percentile curves of the growth velocities.

The data were taken from a longitudinal study, in the course of which children from Budapest were investigated annually from 1970 (their year of birth) to 1988. We have chosen the 665 males and 739 females who had complete records of height to determine their growth velocities.

This can be done in various ways. We have chosen to fit individual growth curves for three reasons. First, for technical reasons: the measurements of all individuals were taken each year during a period of a couple of weeks period, therefore, they were not measured at exactly the same age. This inevitably called for some kind of correction for age, which could easily be done in this way. Secondly, by fitting curves measurement errors and short-term variability could be smoothed out. Finally, perecentiles calculated from the fitted function doesn't need further smoothing.

Two models have been fitted to the data, the nine parameter model suggested by Bock and Thissen (1980) which is in fact the sum of three logistic functions:

$$y = a_1 \left[\frac{1-p}{1+e^{-b_1 (t-c_1)}} + \frac{p}{1+e^{-b_2 (t-c_2)}} \right] + \frac{a_2}{1+e^{-b_3 (t-c_3)}} ;$$

and a seven parameter model recently developed by Jolicouer et al. (1988):

$$y = A \left\{ 1 - \frac{1}{1+ (t/D_1)^{c_1} + (t/D_2)^{c_2} + (t/D_3)^{c_3}} \right\}$$

where y = height, t = age.

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There are several other models used in modelling human growth, however, they have 'een only used in shorter periods, either in infancy and childhood or adolescence. The first model proved to be superior to the other one: it showed lower average residual mean square, therefore, it has been chosen for further calculations (Hauspie 1989).

Velocity values have been determined by calculating the derivatives of the growth curves at preassigned time points. At every timepoint the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles have been determined.

The velocity curves of the boys from their birth to their age of 19 are presented in *Fig. 1*. The median curve is marked by dots. In the first six months the median (over 25 cm/year) as well as the variability are fairly high, both showing a very fast decrease afterwards. In order to render an easier differentiation of the curves, on *Fig. 2* one can see them in the period of 1 to 19 years. On the left the inpact of a small pre-pubertal spurt is expressed in a stagnation of velocities after the steep decrease. The median growth velocity reaches its maximum of 7.5 cm/year at the age of 13.5 years the minimum preceeding it being 4.8 cm/years at the age of 10.5 years. The median at 19 years is 0.6 cm/year and the upper percentiles are still rather far from zero. Higher percentiles show considerably greater differences between the maximum and preceeding minimum then the median, the lower ones, on the contrary, have only a minimal rise in this period. That means, the variability is caused mainly by the significant phase shift in the adolescent growth.

The next two figures present the percentile charts for females. The shapes of curves are similar to those of ones on the preceeding figures. The prepubertal minimum of the median is 5.2 cm/year at the age of 9 years, and a maximum of 6.8 cm/year is at 11 years. At the age of 19 even the higher percentiles are close to the zero, the median being 0.2 cm/year (*Fig. 3* and *4*.).

In order to compare the velocity curves of the boys and girls, on *Fig. 5* the medians as well as the 10th and 90th percentiles of both sexes are shown. Beside the well known adolescent phase difference between the sexes, another systematic difference between the curves can be observed: in early childhood those of females remain higher, then, descending more rapidly, the curves of the two sexes intersect at about six years.

It is well known, that, though the median at a time-point is a value characteristic of the velocities measured at the age, the median curve cannot be considered as a typical growth curve. Because of the phase difference between individuals in adolescent growth it is considerably flatter, with lower maximal velocity at puberty, than individual curves. The median-constant curve having as parameters the medians of those of individual curves has the advantageous property of being a "typical" one. On *Fig. 6* both the median curve and the median-constant curve of the boys are shown. Although the latter has more pronaunced turns, there is only a slight difference, except for the adolescent period. The difference between maximal adolescent velocities is as much as 2 cm/year. The time of maximal velocity is, however, practically unchanged.

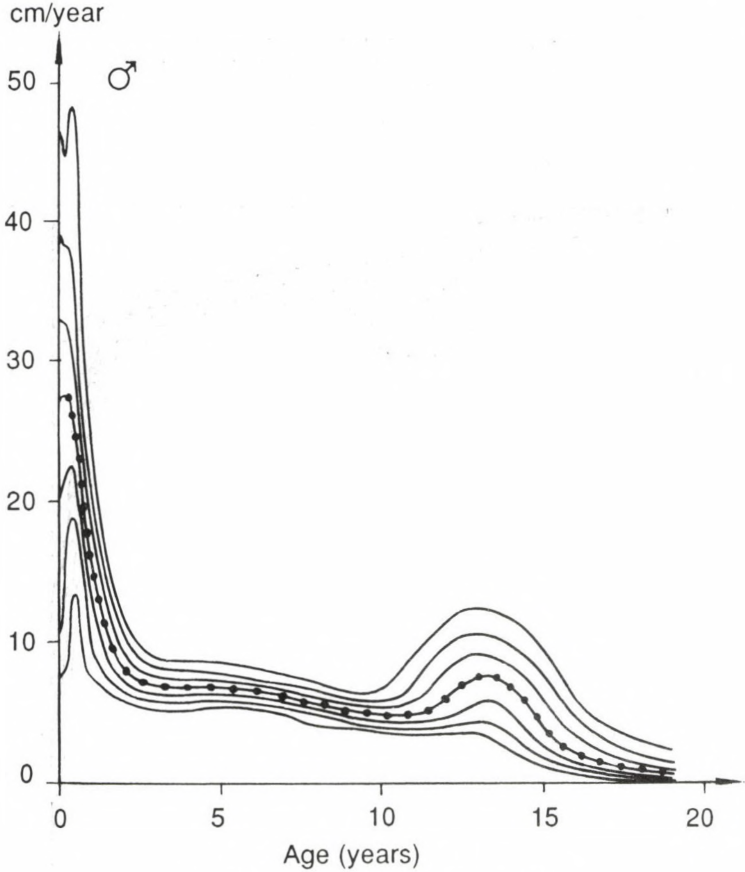

Fig. 1: Percentile curves of growth velocity,
based on the Budapest Longitudinal Growth Study
(males, 0 to 19 years; 3rd, 10th, 25th, 50th, 75th, 90th,
and 97th percentiles)

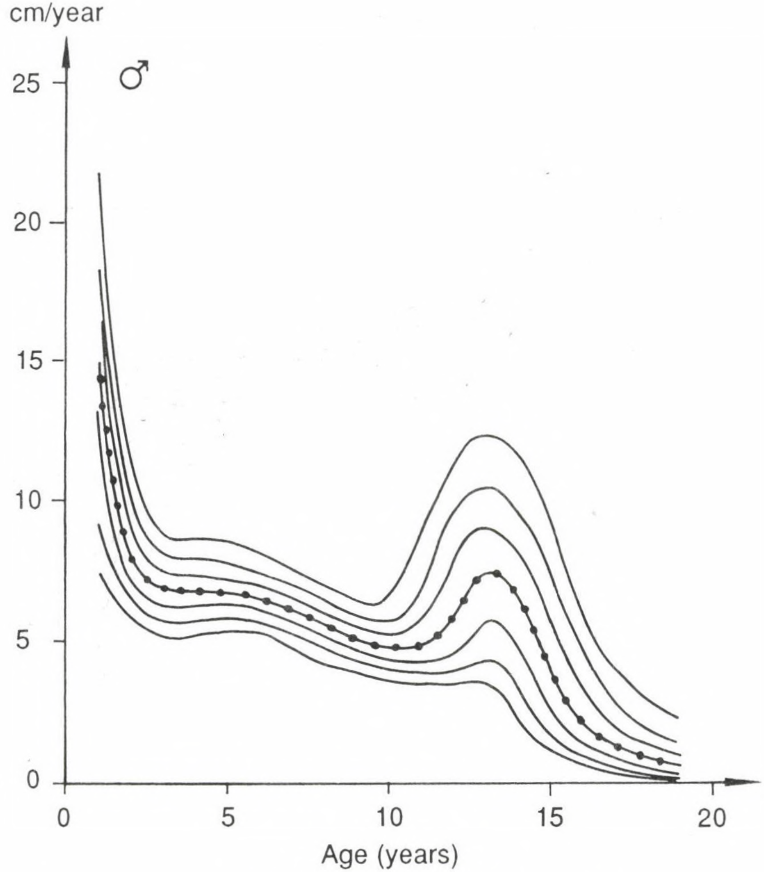

Fig. 2: Percentile curves of growth velocity,
based on the Budapest Longitudinal Growth Study
(males, 1 to 19 years; 3rd, 10th, 25th, 50th, 75th, 90th,
and 97th percentiles)

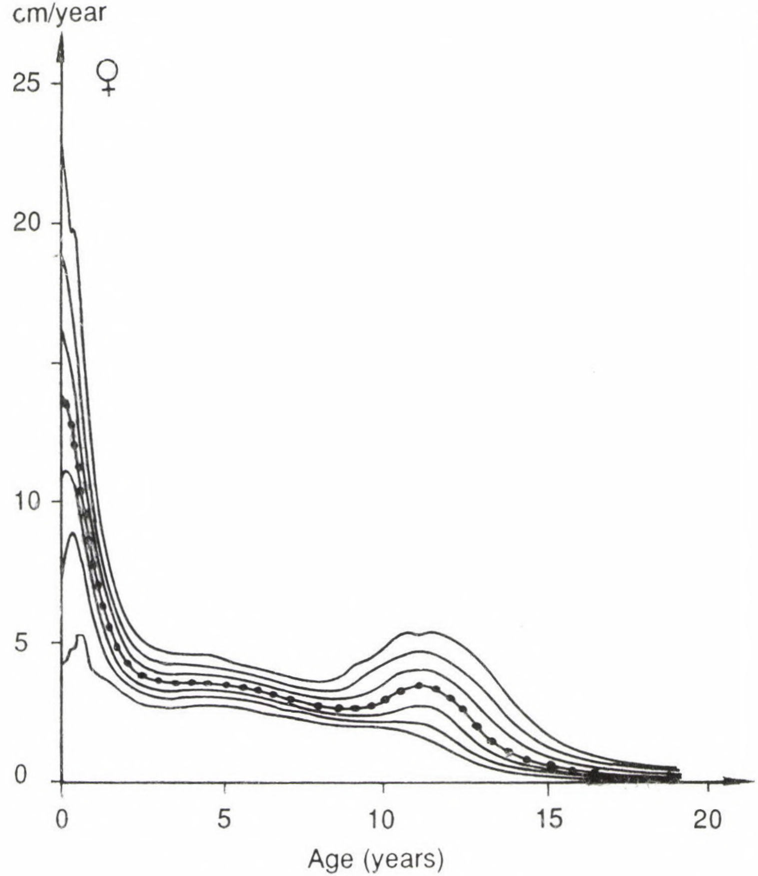

Fig. 3: Percentile curves of growth velocity, based on the Budapest Longitudinal Growth Study (females, 0 to 19 years; 3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles)

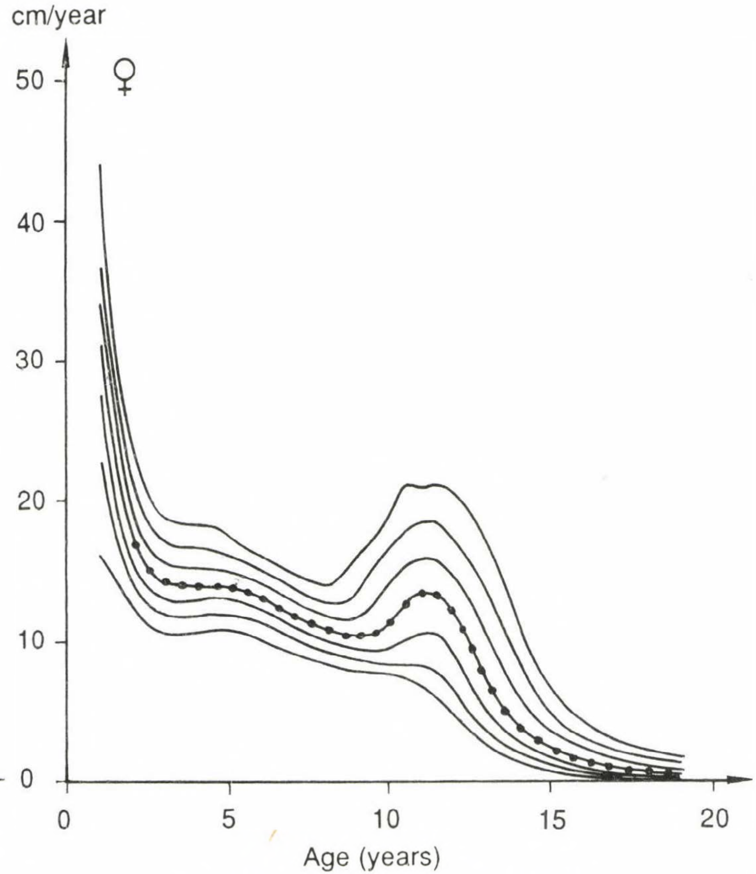

Fig. 4: Percentile curves of growth velocity, based on the Budapest Longitudinal Growth Study (females, 1 to 19 years; 3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles)

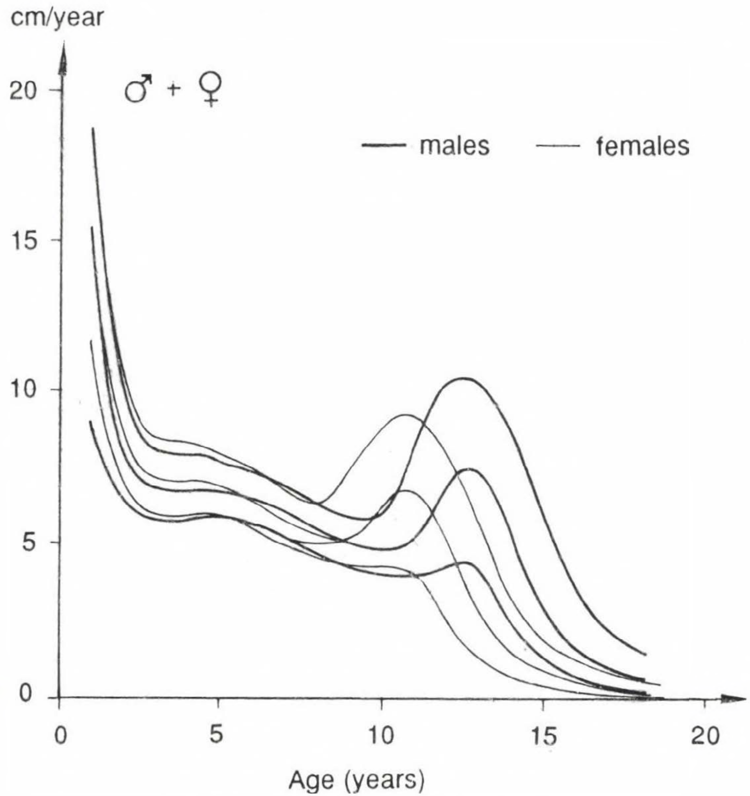

Fig. 5: Percentile curves of growth velocity, based on the Budapest Longitudinal Growth Study (males and females, 1 to 19 years; 10th, 50th, and 90th, percentiles)

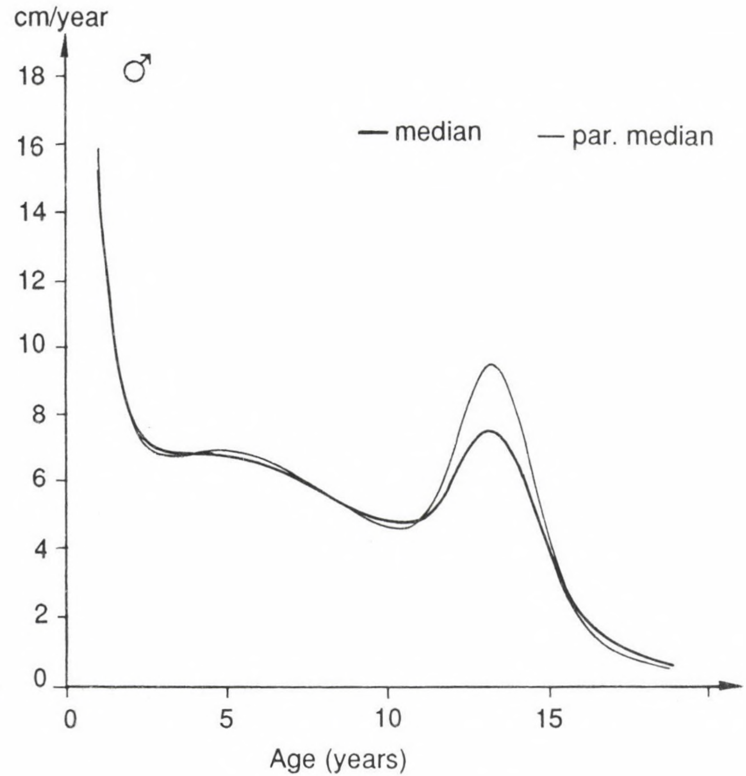

Fig. 6: Percentile curves of growth velocity, based on the Budapest Longitudinal Growth Study (males, 1 to 19 years; median and par. median curves)

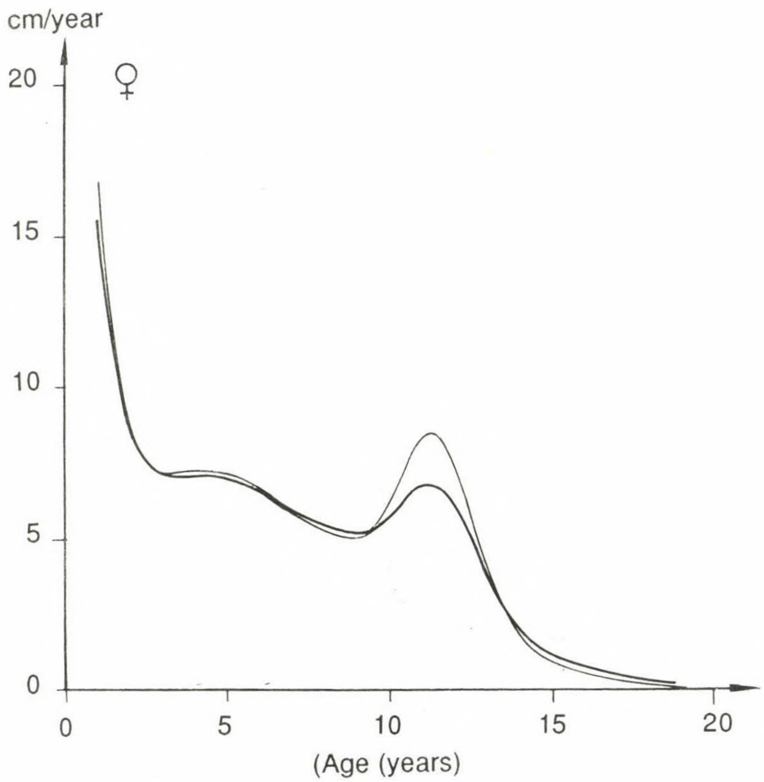

Fig. 7: Percentile curves of growth velocity, based on the Budapest Longitudinal Growth Study (females, 1 to 19 years; median and par. median curves)

The same can be said as far as the girls are concerned (*Fig. 7*).
In conclusion: Percentile curves of growth velocities seem to provide a better insight into the growing process.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. 33; 87–95. (1991)

HEAD CIRCUMFERENCE GROWTH AND CLOSURE OF ANTERIOR FONTANELLE

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Abstract: *Measurement of head circumference and in particular the evaluation of the size of the anterior fontanelle is part of the routine practice during pediatric visits over the first two years of life. The closing of the fontanelle, estimated using palpation, normally takes place between 9 and 20 months according to important pediatric and pediatric neurology textbooks.*

In pediatric practice, however, it often happens that the anterior fontanelle closes before the above mentioned period. Since, to our knowledge, literature presents few data on this issue, we analysed data concerning a large sample of babies (about 11000) born at the "Clinica Ostetrica L. Mangiagalli" in Milan between 1973 and 1979, and a subsample (some 1550 subjects), periodically examined up to the third birthday. The aim of this note is to evaluate the possible relationship of head circumference growth in the first three years of life to the size and age of closure of fontanelle.

Main results were as follows:

At birth the size of the anterior fontanelle is not related to the head circumference.

In the group followed up longitudinally, 24% of the boys and 14% of the girls showed a non palpable anterior fontanelle before the 9th month of life.

No association between the early closing of the anterior fontanelle and the increase of head circumference was shown.

No case was found with the anterior fontanelle closed at birth.

Key words: *Anterior fontanelle; Post natal growth of head*

Introduction

Over the first two years of life measurement of head circumference and the evaluation of the size of the anterior fontanelle is paart of the routine practice during pediatric visits. The closure of fontanelle, estimated by using palpation, normally takes place between 9 and 20 months according to important pediatric and pediatric neurology textbooks (Nelson 1975, Menkes 1975, Barnett 1973).

In pediatric practice, however, it often happens that the anterior fontanelle closes before the above mentioned period. The aim of this note is to evaluate the possible relationship between head circumference growth during the first three years of life and the size of fontanelle and time of its closure.

Subjects and Methods

Subjects

The whole case-series, on which the evaluation of neonatal data was performed, consists of 11574 babies born (live and without detectable congenital anomalies) at the Clinica Ostetrica Ginecologica L. Mangiagalli in Milan between 1973 and 1979; the data were collected in the context of a multicentric research of Perinatal Preventive Medicine supported by CNR (National Research Council). The survey consisted of a cross-sectional part at birth, and of a longitudinal part, up to the third birthday (3, 6, 9, 12, 18, 24, 30, 36 months).

As regards postnatal growth of head, only a subset of 1554 babies (801 males and 753 females) was used; as a matter of fact, only 33% of subjects attended at least the first five visits or a complete follow up till the closure of anterior fontanelle.

With the aim of excluding possible effects of risk factors for postnatal growth, the following inclusion criteria were adopted: birth at term (≥ 37 weeks of gestation), appropriate weight for gestational age (between the 5th and 95th centile), absence of neonatal morbidity (as reported in *Table 1*). The presence of one of the conditions listed on the right of the Table 1 is sufficient to classify an infant as "pathological".

Table 1. **Types of neonatal morbidity**

Neonatal morbidity due to	**Symptom(s)**
Neonatal asphyxia	Five minute Apgar score < 7
Respiratory diseases	Respiratory distress syndrome, Aspiration syndrome Pneumothorax
Central nervous system	Seizures, Apnoeic spells, Hypertonus, Hypotonus
Infections	Sepsis, Meningitis, Lung infections, Gastrointestinal tract infections, Skin and bone infections (positive blood and or spinal fluid culture, pathogenic organisms in stool culture)
Hyperbilirubinemia	Total serum bilirubin (maximum value): ≥ 8 mg% (if determined during the first day of life) ≥ 12 mg% (if determined later)
Hypoglicemia	Blood glucose (minimum value): < 30 mg% (if determined during the first 48 hours of life) < 40mg% (if determined later)

Variables

Head circumference was measured with a tape measure at the largest occipito–frontal circumference. The transverse diameter of the anterior fontanelle (TDAF) at birth was estimated by palpation with an approximation of 0.5 cm and at the follow-up visits as TDAF > 1 cm, TDAF < 1 cm, closure of the fontanelle.

The Kolmogorov-Smirnov test was used to compare two frequency distributions. This tests the null hypothesis that the two populations are identical against a composite alternative concerning the first three moments of the distributions (Conover 1971).

Results

Sex and TDF at birth

Table 2 shows the distribution, for males and females, of the TDAF at birth of the whole set of 11574 subjects. It must be noted that the case-series does not contain babies with a closed fontanelle at birth (craniosynostosis). In fact the minimum value is 2 mm, recorded in 32 males and 26 females, and the modal value is 10 mm. No difference was found between sexes in TDAF (Mean = 14.1 mm, SD = 6.6 mm and Mean = 14.6 mm, SD = 7.0 mm respectively for females and males).

Table 2. **TDAF (mm) distribution at birth, by sex**

TDAF at birth									
< 5	5	10	15	20	25	30	35	Missing	Total
Females									
60 1.08%	661 11.89%	2097 37.73%	655 11.78%	1550 27.89%	100 1.80%	233 4.19%	20 0.36%	182 3.27%	5558 100.0%
Males									
72 1.20%	683 11.35%	2069 34.39%	732 12.17%	1766 29.36%	128 2.13%	324 5.39%	35 0.58%	207 3.44%	6016 100.0%
Total									
132 100.0%	1344 100.0%	4166 100.0%	1387 100.0%	3316 100.0%	228 100.0%	557 100.0%	55 100.0%	389 100.0%	11574 100.0%

Gestational age and TDAF at birth

The mean diameter of the fontanelle at birth varies from 13 mm for babies born between 28 and 31 weeks of gestation, to 14.5 mm for babies born between 37 and 41 weeks (*Table 3*). Taking into consideration the method of measurement (palpation) the differences are not clinically relevant. The same results (not shown) were found in the subset of the 1554 selected babies.

Table 3. **Means and standard deviations (SD) of TDAF (mm) at birth for gestational age (completed weeks)**

Gestational age	N	TDAF at birth Mean	SD
28 – 31	125	13.0	6.2
32 – 36	1276	13.7	6.3
37 – 42	9586	14.5	6.9
> 42	110	14.0	7.3
Total	11097	14.4	6.8

Head circumference and TDAF at birth

Figure 1 shows the frequency distributions of head circumference at birth in the three classes of babies grouped according to their TDAF (< 10 mm, 10–15 mm, ≥ 20 mm respectively: these distributions substantially overlap.

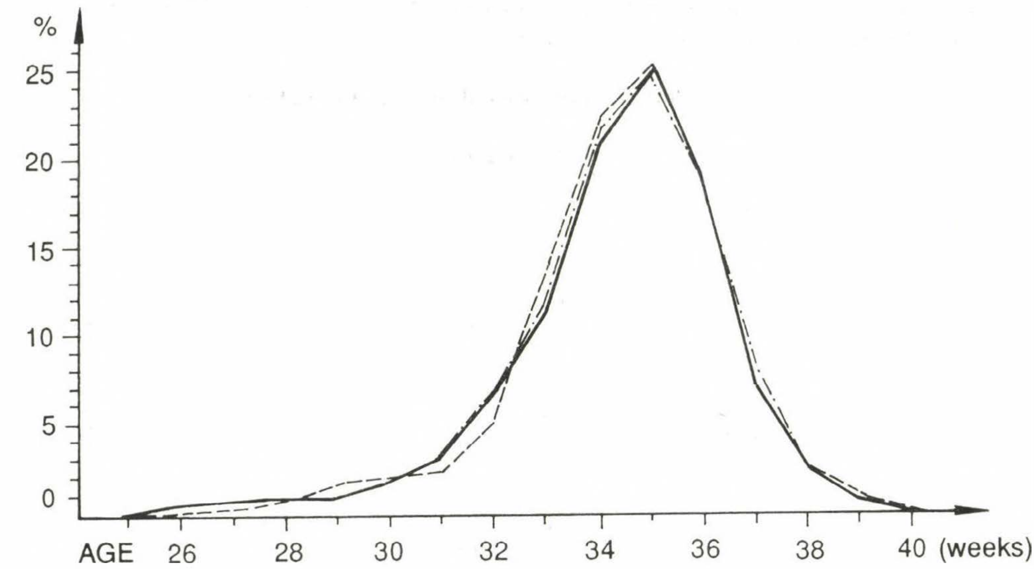

Fig. 1: Frequency distribution of head circumference at birth by TDAF at birth: < 10 mm (————); 10–15 mm (- - -) and ≥ 20 mm (- . - . -)

There are no statistically significant differences in TDAF for different head circumference: the average values of the TDFA vary from 14.3 mm (head circumference at birth: 33 cm) to 14.8 mm (head circumference at birth: 37 cm) (*Table 4*).

Table 4. **Means and standard deviations (SD) of TDAF (mm) at birth for different head circumference at birth (cm)**

Head circumference at birth	TDAF at birth N	Mean	SD
≤32	1489	14.3	6.6
33	1295	14.3	7.0
34	2383	14.3	6.7
35	2763	14.4	6.9
36	2040	14.3	6.9
37	854	14.8	6.8
≥38	361	14.7	6.6
Total	11185	14.4	6.8

Premature closure of the fontanelle and TDAF at birth

Approximately 50% (range interquartile) of the 1554 babies showed closed fontanelle within 10 and 17 months of life. A total of 300 babies 196 males (24.5%) and 104 females (13.7%), showed their fontanelle closed up to 9 months (premature closure).

In *Table 5* the TDAF distribution at birth (3 classes) of the babies with premature closure of the fontanelle is compared with the corresponding one of the remaining babies (control group). The chi-square test for linear trend (χ^2 = 55.6, d. f. = 1) is highly signi icant, showing that the frequency of premature closure tends to increase as the TDAF at birth tends to decrease (see *Table 5*).

Table 5. **TDAF (mm) at birth for group with premature closure of the fontanelle and control group**

Group	TDAF at birth			
	< 10	10–15	≥ 20	Total
Premature closure	88 (13.10)	137 (16.14)	35 (8.77)	260
Control group	195 (68.90)	712 (83.86)	364 (91.23)	1271
Total	283	849	399	1531

χ^2 (linear trend) = 55.6   d.f = 1 ($p < 0.001$)
χ^2 (departure) = 3.78   d.f = 2 ($p \sim 0.05$)

Premature closure of the fontanelle and growth head circumference at birth

Figure 2 shows the frequency distribution of head circumference at birth of the premature fontanelle closure group and of the control group. No statistically significant difference emerges.

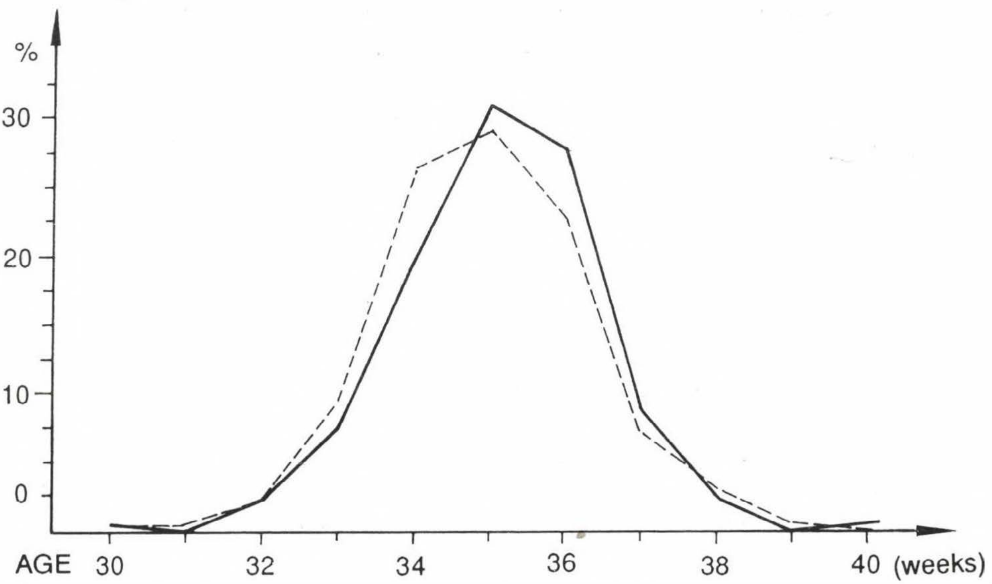

Fig. 2: Frequency distribution of head circumference at birth in premature fontanelle closure group (————) and control group (- - - -)

In order to investigate whether the premature closure of the fontanelle has an effect in reducing growth of the child's head, average and standard deviation of head circumference at birth, at one, two and three years of life were computed for males and females separately (*Table 6*). The means of head circumference of the control group (age of closure ≥ 9 months) are constantly higher than those of the premature closure group: the maximum difference observed (0.65 cm) does not appear to be of clinical interest. Thus, it seems that head circumference (from 3 months to three years) is not affected by the age of closure of anterior fontanelle.

Table 6. **Means and standard deviations (SD) of head circumference (cm) at birth and at one, two and three years of life for premature fontanelle closure group and control group**

Head circumference	Females		Males	
	Premature fontanelle closure group	Control Group	Premature fontanelle closure group	Control group
Birth				
N	85	656	168	609
Mean	34.44	34.70	35.44	35.20
SD	1.31	1.25	1.19	1.34
1 year				
N	72	659	154	612
Mean	45.15	45.55	46.55	46.64
SD	1.41	1.21	1.14	1.30
2 years				
N	42	471	109	452
Mean	47.36	48.01	48.74	49.08
SD	1.48	1.23	1.29	1.34
3 years				
N	36	416	97	411
Mean	48.83	49.21	50.00	50.14
SD	1.40	1.62	1.48	1.32

It must be noted that in some 2% only of the infants the closure of the anterior fontanelle is earlier than 6 months of age and that no baby of this 2% showed any significant change in the pattern of growth of head circumference (*Table 7*). Even for the 4 infants with closure of the anterior fontanelle at 3 (1 female and 1 male) and 4 months (2 males) head circumference continued to increase from birth to 3 years following their growth centile (see *Fig. 3* as an example). Further the average head circumference of subjects with closure of fontanelle at 5 months does not deviate from the standard reference values (Milani et al, 1988).

Table 7. **Head circumference (cm) from birth to three years for babies with closure of fontanelle before 6 months of life**

Month of closure of anterior fontanelle	Head circumference months								
	birth	3	6	9	12	18	24	30	36
Females									
3	35	39	42	43	44	45	46	47	47
5	33	37	40	41	43	44	44	–	–
5	33	38	43	44	46	–	49	49	–
5	34	40	44	45	47	–	–	–	–
5	35	39	42	43	45	–	–	–	–
5	33	40	42	–	–	–	–	–	–
5	34	39	42	44	46	47	48	49	49
5	34	40	42	–	–	–	–	–	–
5	35	40	44	–	–	–	–	–	–
Males									
3	36	43	46	48	48	50	50	–	51
4	35	41	42	–	–	–	–	–	48
4	34	41	–	–	–	–	–	–	51
5	36	41	42	–	–	–	–	–	–
5	40	42	44	47	48	50	50	50	51
5	37	40	43	–	–	–	–	–	–
5	36	40	44	45	47	49	–	–	–
5	35	40	43	–	–	–	–	–	49
5	38	42	44	47	–	–	–	–	52
5	35	40	43	–	–	–	–	–	50
5	38	42	47	–	49	50	50	50	51
5	36	41	44	–	–	–	–	–	–
5	36	40	44	46	48	–	–	–	50
5	34	39	42	44	45	46	47	48	48
5	–	39	42	44	46	–	–	–	–
5	36	39	43	45	46	48	49	49	–
5	36	41	44	46	47	49	50	50	50
5	36	40	42	45	46	47	48	49	49

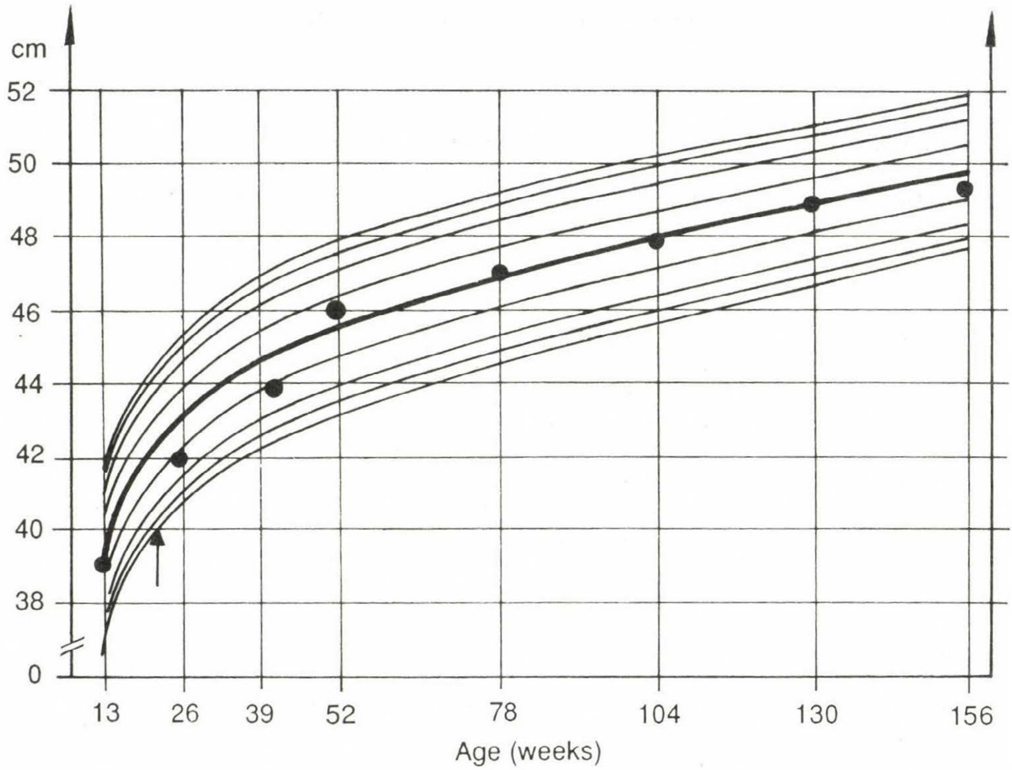

Fig. 3: Growth profile (circles) of girl No. 44342, plotted on Italian growth standards 0–3 years (3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 97 th centile).
The arrow indicates the time of closure of anterior fontanelle

Discussion

The closure of fontanelle is part of the normal process of skeletal maturation, and it is a fundamental observation in the global evaluation of a child's growth. The premature closure of the anterior fontanelle must always be considered in relation to the growth of head circumference and a careful examination of the baby is needed in order to exclude pathological situations such as craniosynostosis (closure of the fontanelle present at birth), or decrease in brain development with consequent primary (present at birth) or secondary microcephaly. The present study does not include any case of fontanelle already closed at birth (Matson 1969), nor subjects with primary or secondary microcephaly.

Infections, traumas, metabolic diseases and anoxic status during the last months of pregnancy, the perinatal period and early infancy may induce brain damage with reduced postnatal head growth and premature closure of fontanelles (Menkes 1975).

Rare cases of closure of anterior fontanelle prior to 6 months of life with normal mental development have been described elsewhere (Barnett 1973). In this study, the 27 subjects with closure of the anterior fontanelle prior 3–6 months did not show significant changes in the pattern of head circumference growth.

This study confirms that the closure of the anterior fontanelle prior to 3–9 months of age, in the absence of peri- and postnatal problems does not appear, by itself, to determine variations in the growth of head circumference. The fibrose union of suture lines, which generally persists until 12 years of age, is likely to permit the normal growth of head circumference. The premature closure of the anterior fontanelle, even without other pathological data, requires, in any case, strict longitudinal observations.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 22 July, 1991.

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Anthrop. Közl. *33;* 97–103. (1991)

DEVELOPMENTAL RATE IN DEBRECEN GIRLS FROM THE AGE OF 7 TO 22 YEARS

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Abstract: *100 girls were randomly selected from those involved in Debrecen Longitudinal Studies. From their developmental data ranging from the age of 7 to 22 years the authors calculated the annual growth of the parameters consecutively measured (height, weight, chest circumference, lean body mass and vital capacity) and determined the average age of peak velocities and the percentage of those developing earlier or later than the average. It was found, that about the half of the sample belong to the middle groups with average age of the peak velocities.*

Key words: *Debrecen Longitudinal Growth Study; Girls 7–22 years of age; Peak velocities of growth and development; Early and late development*

Introduction

Only the pure longitudinal studies are suitable for determination the real annual growth and development of the children and adolescents. This sort of studies especially which continuously observed the subjects studied to their adulthood, are limited owing to the long-continued researches. In addition to the increase of the anthropometric characteristics, vital capacity is of great importance, which indicates the development of the lung and the respiratory muscles. This points out wether development and physiological function of the lung are accompanied by changes in size or not (Szöllősi, 1982). We reported on the partial results of the Debrecen Growth Study in several papers (Szöllősi – Jókay 1986, 1988). Now our 2nd longitudinal study is in the proces of completion. Out of school children born between 1965 and 1968, the girls' longitudinal study was finished at the age of 22. During this long period of time, personal contacts became well-established dropping out of subjects was minimal. Thus, after calculating the usual developmental parameters, determination of the real annual growth as well as the term of the peak velocities of growth and rate of earlier or later developing girls seemed to be reasonable.

Material and Methods

The first step was the random selection of 100 girls from the original sample. Their development was evaluated by means of an American computer program medified by us. The parameters elaborated were as follows: body height, weight, chest circumference in normal position, in maximal inhalation and in maximum expiration, lean body mass and vital capacity.

Data obtained were divided in order of magnitude into 5 groups according to each parameter and age, so, that the middle group should consist of the average value ± a half standard deviation. Thus, the average rate and (taking into consideration the extreme groups) the percentual rate of the parameters could be determined with a much lower or higher value than the average. Then, it was found out at which age to which group the parameters of each girl belong. Based on the above calculations we determined the rate of girls developing later or earlier than the average.

Results

The average increase of *body height* between 7 and 8 years of age is 6.4 cm with a standard deviation of 1.19 cm. The tempo of growth decreases till the age of 10 and then the peak velocity appears with an average value of 6.7 cm from the age of 10 to 11, as we mentioned in our earlier paper (Szöllősi 1981a, b, Szöllősi and Jókay 1985). Then, growth rate gradually diminishes again and it does not even reach 1 cm from the age of 15 to 16 and it is 0.1 cm a year at the ages of 19 and 20. Girls' body height increases 0.6 cm altogether from 18 to 22 (*Fig. 1*). The standard deviation of the annual growth gradually increases and reaches its maximum between the ages of 12–14: 2.047 and 2.025 cm, respectively. Thereafter it decreases step by step and after 16 its amount can be measured only in decimals.

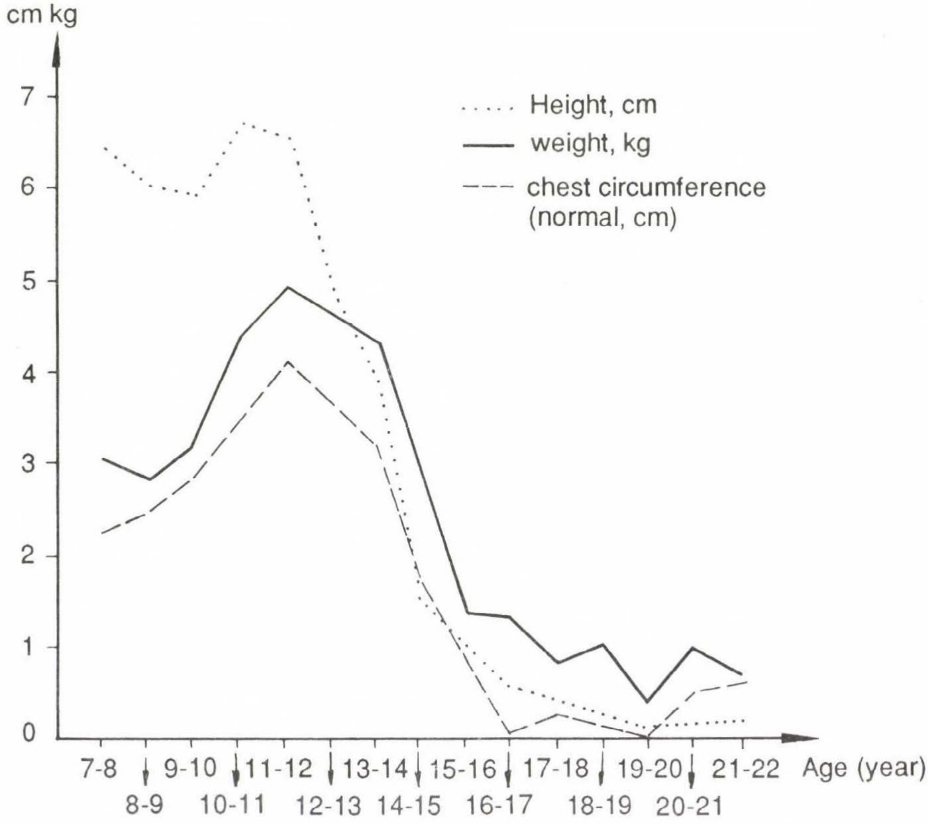

Fig. 1: The annual increments of height (cm), weight (kg), and chest circumference (normal, cm) in Debrecen girls

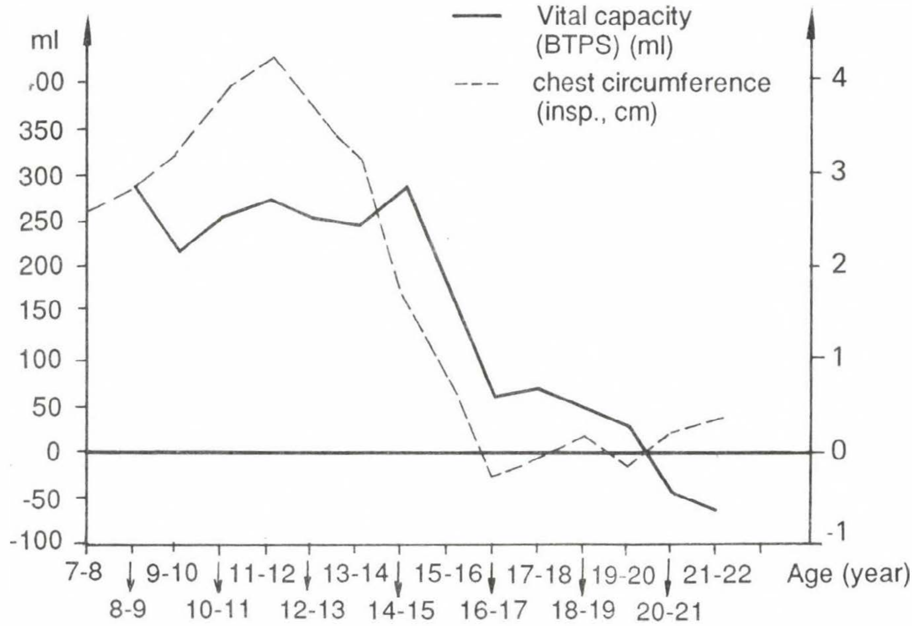

Fig. 2: The annual increments of vital capacity (ml), and chest circumference (maximal inspiration, cm) in Debrecen girls

As far as *body weight* is concerned peak velocity occurs one year later (Szöllősi 1981a, b, Szöllősi and Jókay 1985, 1988): it is almost 5 kgs from the age of 11 to 12, then its rate decreases gradually and it is not as much as 1 kg after 17 year of age.

The increase in *chest circumference* follows that of body weight. The increment in lean body mass is similar, however, while lean body mass constitutes the majority of gain in weight between 12 and 13, the increase in body fat percent will predominate at a later age (Szöllősi and Jókay 1988).

The increase in *vital capacity* varies between 220 and 290 mls between the ages of 8 and 15, then its rate gradually decreases, its increase, however, continues till the age of 20. From this age onward we get negative values only. It is a well-know fact that the vital capacity of grown-ups decreases parallel with age. Earlier this phenomenon was observed to begin at the age of 16 (Anthony and Venrath 1962), it seems to start somewhat later in the generation growing up now *(Fig. 2)*.

The standard deviations of the weight, chest circumferences and vital capacity reach the highest degree between the ages of 14–16 (weight: 2.793 and 2.890 kg, chest circumference in normal position: 2.552 and 2.832 cm, VC: 0.331 and 0.301 lit.). The highest standard deviation are caused by rate of individual increment that is more variable in puberty.

The classification of the individual annual growth parameters according to the order of magnitude suggest that there are cases where annual increase cannot be measured. There is even a reduction of body weight which is accompanied by that of chest circumference and lean body mass, too. This can be observed especially in patients inclined to getting fat. Similar values can be obtained concerning body height if there is no change or, if there is some, but within the limit of measurement error.

If this was the fact, the first group consisted of these cases. Such values were found in the case of body height from the age of 13 (*Table 1*). While the rate of non-growing girls was 1 to 8% from the age of 13 to 15, their rate gradually increased up to 26–27% after 15. The rate was about 50%, varying between 29 and 53%, in the middle group, with $\bar{x} \pm$ a half SD. Group 5 comprises girls with an extremely high growth rate. Their rate varied between 1–12%.

Table 1. **The percentual rate of stature's growth velocity in the Debrecen girls in the middle ($\bar{x} \pm 0.5$ SD) and the extreme groups**

Group:	1.	3.	5.
Age (years)		percentage	
13 – 14	1	32	9
14 – 15	8	49	3
15 – 16	11	53	1
16 – 17	17	29	1
17 – 18	19	37	12
18 – 19	26	41	10
19 – 20	21	47	6
20 – 21	27	53	2
21 – 22	26	48	9

As we have already mentioned it is a common phenomenon in girls that there is a year when their body weight does not grow or it even decreases. After the age of 15 this rate increases from the earlier 1 to 11% to 17 to 38%. The rate of girls belonging to the middle group is about 50% varying between 37 to 61%. An extreme gain in weight was observed at a rate of 2 to 13% (*Table 2*).

Table 2. **The percentual rate of gain of weight in the Debrecen girls in the middle ($\bar{x} \pm 0.5$ SD) and the extreme groups**

Group:	1.	3.	5.
Age (years)		percentage	
7 – 8	7	51	9
8 – 9	5	55	7
9 – 10	3	50	8
10 – 11	2	43	5
11 – 12	1	61	4
12 – 13	2	40	9
13 – 14	2	45	5
14 – 15	11	40	7
15 – 16	22	47	3
16 – 17	17	37	5
17 – 18	26	49	6
18 – 19	26	53	2
19 – 20	38	37	5
20 – 21	23	52	5
21 – 22	26	48	13

The annual increase in chest circumference and LBM gave practically similar results. As far as vital capacity is concerned the rate of slowly developing girls was 4 to 10% till the age of 8 to 14, then it gradually increased to 19–52%. In the middle group the rate varied between 28 to 48%, and was 1 to 9% in the group with an extremely high annual increase (*Tables 3, 4,* and *5*).

Table 3. **The percentual rate of increase of chest circumference in the Debrecen girls in the middle ($\bar{x} \pm 0.5$ SD) and the extreme groups**

Group:	1.	3.	5.
Age (years)	percentage		
7 – 8	1	37	7
8 – 9	1	45	5
9 – 10	2	50	2
10 – 11	1	45	4
11 – 12	8	43	6
12 – 13	3	40	2
13 – 14	3	52	4
14 – 15	19	39	7
15 – 16	29	44	2
16 – 17	23	43	7
17 – 18	33	39	4
18 – 19	31	32	19
19 – 20	33	37	6
20 – 21	20	64	3
21 – 22	22	56	13

Table 4. **The percentual rate of increment of LBM in the Debrecen girls in the middle ($\bar{x} \pm 0.5$ SD) and the extreme groups**

Group:	1.	3.	5.
Age (years)	percentage		
10 – 11	17	50	33
11 – 12	17	50	33
12 – 13	–	34	13
13 – 14	4	46	3
14 – 15	21	41	5
15 – 16	30	39	3
16 – 17	29	43	5
17 – 18	32	40	12
18 – 19	28	50	2
19 – 20	27	52	3
20 – 21	28	52	3
21 – 22	30	44	9

Table 5. **The percentual rate of increment of vital capacity in the Debrecen girls in the middle ($\bar{x} \pm 0.5$ SD) and the extreme groups**

Group:	1.	3.	5.
Age (years)	percentage		
8 – 9	5	38	9
9 – 10	4	28	5
10 – 11	4	49	6
11 – 12	6	44	3
12 – 13	9	46	5
13 – 14	10	52	4
14 – 15	19	39	7
15 – 16	22	50	5
16 – 17	27	45	1
17 – 18	22	53	4
18 – 19	23	53	6
19 – 20	23	48	1
20 – 21	20	48	2
21 – 22	48	48	4

Evaluating individual worksheets we observed in the case of some girls that growth – especially in body height – stopped entirely following peak velocity and then it started again at a low rate. This phenomenon cannot be observed in the average values because it is covered by the values of girls with an earlier and later development, respectively. This is demonstrated on *figure 3*, where the average annual growth of body hight is illustrated compared with the velocity curves of an earlier and a later developing girl. The overlappings are obvious.

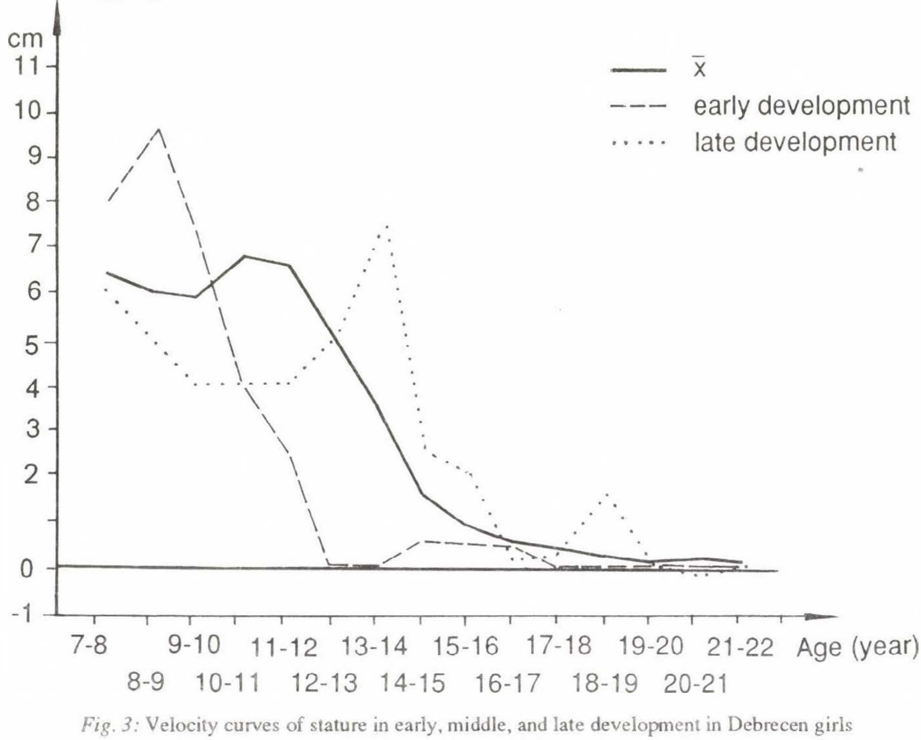

Fig. 3: Velocity curves of stature in early, middle, and late development in Debrecen girls

Furtheron, is it conspicuous that peak velocity occurs at the time corresponding to mean age only in 43% of girls, while it occurs at a later date in 34% of them and at an earlier date in 23% of them. The time span is 1 year in some of them, however, it can last as long as 2 years.

On evaluating the individual worksheets it was also found that development finished at the age of 18 in some girls, however, it could be over at the age of 22 in others. The rate of these data and their further detailed evaluation is in progress.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 1 August, 1991.

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Anthrop. Közl. *33;* 105–111. (1991)

A COMPARISON OF SOMATIC AND MOTOR CHARACTERISTICS IN ARAB AND HUNGARIAN PUPILS

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Abstract: *It is an exciting problem of human biology, education and replacement in sports to compare young representativies of two populations differing in geographical situation, in history and in customs. There were examined 313 girls and 1125 boys in Hungary and 319 girls and 1053 boys in Lybia, aged 10–18 years. The anthroppometric characteristics were as follows: height, body weight, chest circumference in rest, upper arm circumference in flexion, and thigh circumference. The conditional capacities were examined through the tests: 30 m running, Cooper test, Abalakov test, trunk bending. The paper presents the specific development found in the characteristics examined broken down according to naationalities and sex. It can be found differences in the biological development as a consequence of the effects of social (educational and family) environmental factors.*

Key words: *Growth and development; Motoric development; Lybian boys and girls; Hungaarian boys and girls.*

Introduction

In our study we compared the Lybian and Hungarian pupils' somatomotor capacities. It is veerified in the literature as well as in the praxis that the movement performance is determined by the somatic structure. But besides the biological development we must calculate the social effects, too. That's why the comperative analysis of pupils, living on different continents, among different general social and family traditions, studying in different school-systems, seemed to be useful for the education and sport-policy as well, besides the human-biological results.

We examined Lybian and Hungarian pupils. Their age varied from ten to eighteen years.

Our questions were:

1 What similarities and differences can be found in the somatic characteristics of Lybian and Hungarian Pupils?

2. What similarities and differences can be found in the conditional abilities of Lybian and Hungarian Pupils?

3. What dinamics can be found in the changes of capacities between the ages of 10–18?

4. What somatomotor capacities are in the groups created according to the number of children in the families?

Material and Methods

The Lybian measurement has been executed in Tripoli in 1988. The data of Hungarian pupils were chosen from the data-bank at the University of Physical Education, in the Ball games' Department, according to age and sex groups. All together we examined 632 girls and 2178 boys, that is 2810 pupils (*Table 1*).

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Table 1. **Age-distribution of the Hungarian and Lybian pupils examined**

Age (years)	Hungarian			Lybian			Total		
	girls	boys	together	girls	boys	together	girls	boys	together
11	44	198	153	59	198	158	84	217	312
12	32	111	143	32	111	143	64	222	286
13	55	178	233	55	129	184	110	307	417
14	37	162	199	37	164	201	74	326	400
15	40	183	223	40	158	198	80	341	421
16	31	136	167	31	136	167	62	272	334
17	40	115	155	40	115	155	80	230	310
18	34	131	165	34	131	165	68	262	330
Total	313	1125	1438	319	1053	1372	632	2178	2810

The anthropometrical methods were taken by Martin (Martin – Saller 1957) (1) and Mészáros (1987), the conditional capacities were examined by traditional test, published by Nádori and his co-workers (1989).

Anthropometry	Conditional capacities
1. Height (cm)	6. 30 m running (s)
2. Body mass (kg)	7. Cooper test (m)
3. Chest circumference in rest (cm)	8. Abalakov test (cm)
4. Upper arm circumference flexed (cm)	9. Trunk bending forward (cm)
5. Thigh circumference (cm)	

There were observed the muscularity of body parts, the explosiveness, the aerob endurance and the flexibililty of joints. The average and standard deviation were calculated according to usual mathematical statistical methods. We used the double T test and trend equations. Now we intend to show the mean results and the discussion.

On the (*Table 2*) it can be seen the abilities according to the nationality and sex. Only the significant differences are described in the starting and in the final age (that means 11 and 18 years).

Among Lybian pupils in the age 11 there is no difference between the somatic characteristics of boys and girls, but the boys' abilities are better. In the age of 18 the boys have bigger results in the linear and fulness signs. The similar thigh circumference in the case of girls is due to the fatty layer under the skin, in boys to the muscles.

The Hungarian boys are bigger and stronger already attaining the age of 11. The girls showed better mobility in the joints.

As for the two groups of pupils the 11 years old girls show similarity sometimes, but later the Hungarians have bigger or better values; the mean values of Hungarian boys are significantly better than those of the Lybian ones.

Table 2. **Differences in characteristics***

Characters	Group	L – L		H – H		L – H		L – H	
	Age	**11**	**18**	**11**	**18**	**11**	**18**	**11**	**18**
1. Height	(cm)						H	H	H
2. Body mass	(kg)							H	H
3. Chest circumference	(cm)						H	H	H
4. Upper arm circumference FL.	(cm)					H		H	H
5. Thigh circumference	(cm)					H	H	H	H
6. 30 m running	(s)					H	H	H	H
7. Cooper-test	(m)					H	H	H	H
8, Abalakov-test	(cm)					H	H		H
9. Trunk bending forward	(cm)					L	L	L	L

* Sings: = The boys' value is bigger or better

= The girls' value is bigger or better

L = The lybians's value is bigger or better

H = The Hungarians' value is bigger or better

Figure 1 shows the changes during the eight years. Taking the bigger standard error we show the process with linear trend equations. As for the *height*, the changes in both sexes are similar, but the Hungarians are taller (*Fig. 1a*). *Body mass:* the Lybians get near to the Hungarian boys and girls, but they develop in different way (*Fig. 1b*). The *chest circumference* is similar in boys and girls in both groups. The change during the eight years is more pronounced in the case of boys (*Fig. 1c*). *Upper arm* inflexed: The difference between the sexes is getting less in Lybians, it is growing in Hungarians (*Fig. 1d*). There is no significant difference in the *thigh circumference* of boys and girls anywhere. But the values are bigger among Hungarians (*Fig. 1e*).

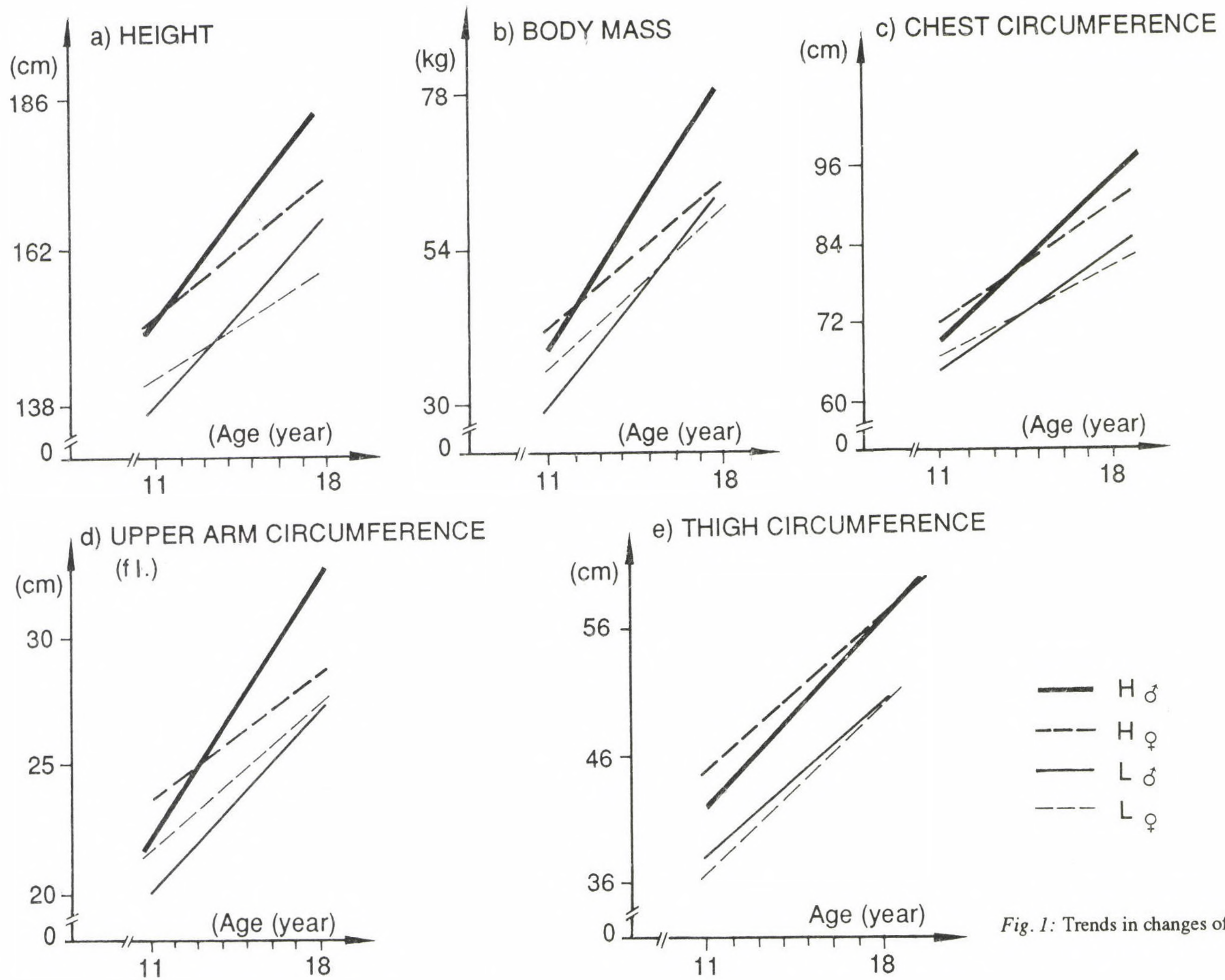

Fig. 1: Trends in changes of somatic characteristics

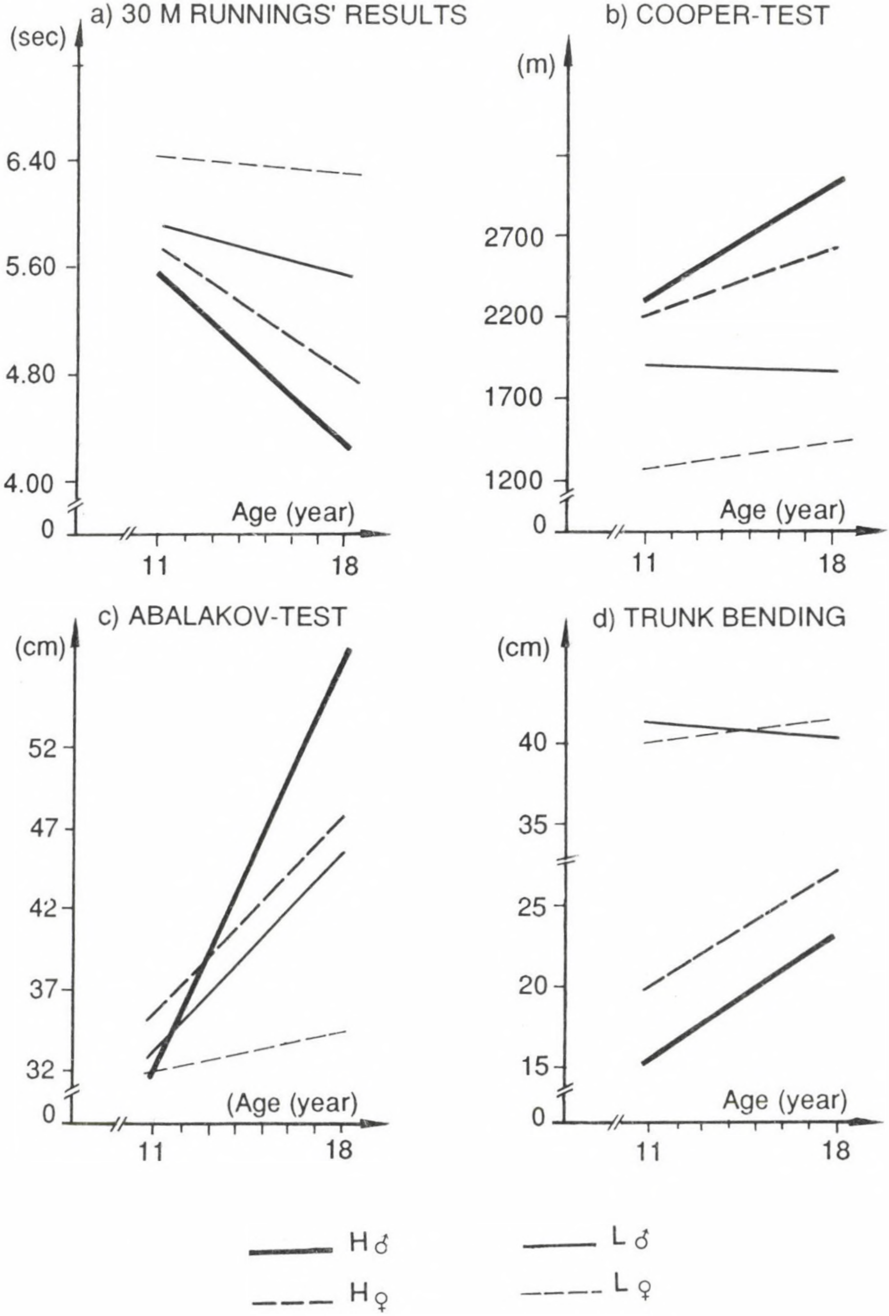

Fig. 2: Trends in changes of conditional abilities

Thirty meter running: The Lybian girls don't develop, the boys do a little. In Hungarians there is a significant development (*Fig. 2a*). *Cooper test:* There is a moderate improvement in Hungarian girls, but this is not the case among Lybians. As for the boys, the Hungarian values are much better (*Fig. 2b*). *Abalakov test:* There is a little improvement in Lybian girls, in Lybian boys it is significant, but in Hungarians it is better too (*Fig. 2c*). *Trunk bending* forward: In this test the girls' values are better in both countries. As for the populations, the Lybians reached better results (*Fig. 2d*).

It is an exciting human biological question, what somatic characters and abilities have the pupils living in large families comparing the results with others. We have compared families with 1–4, 5–8, 9–12 children or more. We found significant differences many times, in spite of compensating processes. In the background we found living in a large family and having been born later in chronological order. The biggest differences are in the age of thirteen, to the injury of the great families. The problem is more often in girls. The difference is the largest in somatic characteristics: body mass, upper arm and chest circumference and height. As for the abilities: the result of thrity meter running (requiring explosivness) is worse in pupils living in great families. Now we wanted only to give the broad outlines of the problem. But the starting results stimulate us to further work.

The main statements of our examination are the following:

(1) In the age of 11, among the Lybian pupils there is no sexdifference in the basic somatic characters. In Hungarians the bigger or higher values of boys are demonstrable alread this time.

In the age groups of 18 the boys' values significantly surpass those of girls in both countries.

The somatic characters of Hungarian boys and girls significantly surpass that of Arabian pupils.

(2) The structural advantage of Hungarian pupils is growing in the field of conditional abilities. In tests for quickness, explosivness and aerob endurance the Europeans are better significantly.

The Arabians show better results in joint-mobility.

In conditional abilities the boys reach higher level but the dynamic leg force is greater in 11 years old girls in both countries.

(3) The development of characteristics is greater mostly in Hungarians in spite of the fact that the lower starting values of Arabian pupils would offer a greater development. There is a great retardement of Lybian girls in explosivness and aerob endurance.

In identic population the development of boys surpass that of girls.

(4) Pupils living in great families show worse somatomotor characteristics – mainly the girls – that those living with 1–4 sisters or brothers.

We consider the examinations as signs that inspire us to further ones in this direction.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 26 June, 1991.

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Anthrop. Közl. *33;* 113–122. (1991)

THE METHOD OF PROBITS IN AUXOLOGY

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Abstract: *Since probit analysis, the classical method of analysis of dose-response relationships, in 1950 has first been applied to status quo data on menarche it has increasingly been used in auxology. This method can profitably be used whenever mean ages of occurrence of qualitative events in the development of children and youths have to be estimated from status quo data. In spite of its widespread use details concerning computational techniques with their implications on the reliability of the estimates, however, are hardly ever mentioned. The main focus of the present paper will thus be on the different approaches to estimate the parameter vector* (μ,σ^2)*, which range from graphical solution techniques to the maximum-likelihood principle. The merits and drawbacks of the different methods will be demonstrated using a set of empirical data on menarche. Finally the importance of testing the underlying assumption concerning the distribution of the time variable is stressed.*

Key words: *Status-quo Method; Probit Analysis; Menarche.*

Introduction

Probit analysis is the classical method of analysis of dose-response relationships. Since Wilson and Sutherland in 1950 first applied this method to status quo data on

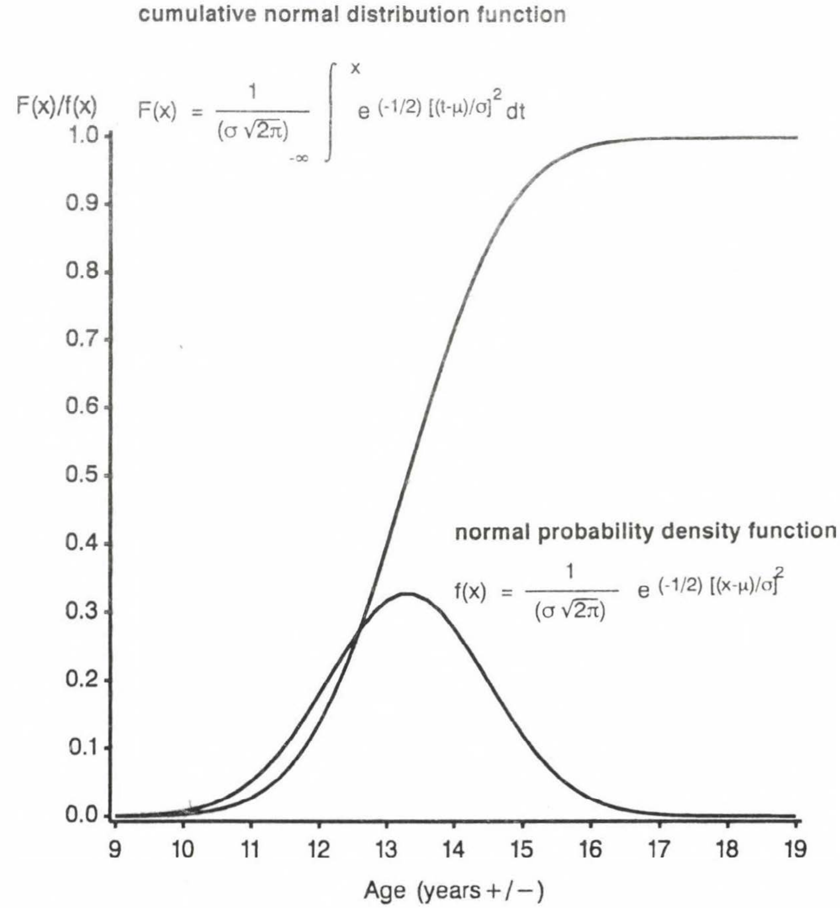


Fig. 1: Relation between age (independent variable) and probability of trait occurrence by a normal distribution

menarche it has increasingly been used in auxology. The method of probits can profitably be used whenever descriptive statistics of the distribution of qualitative events in the development of children and youths, like occurrence of menarche, occurrence of certain stages of the development of secondary sex characteristics or eruption of primary or secondary teeths have to be estimated from status quo data. In this context the dose or independent variable is represented by the age variable, the response or dependent variable is a dichotomic variable (yes or no) which indicates whether the trait under consideration has already occurred or not.

An important basic assumption in probit analysis is that the trait under consideration represents a normally distributed random variable – an assumption which, as far as the distribution of qualitative events in the development of children is concerned, might not always be the best one. The normal probability density function can be represented by the bell-shaped graph shown in *Figure 1*.

The underlying function depends on the mean μ which determines the location of the distribution and the standard deviation σ, which determines its shape. The function f (x) – which depends on age – represents the probability with which the trait occurs at a given age. However, when we are dealing with status quo data on the occurrence of a specific trait, we do not have informations concerning the probability that the trait occurs *at a given age* but, we do have informations about the probability that the trait has already occurred *prior to or at this age;* this distribution is represented by the cumulative normal distribution function (see *Figure 1*). That is we do have observed relative frequencies of individuals showing a response by age of the form shown in *Figure 2*.

The problem to be solved is to estimate the parameter vector (μ,σ^2) which produces the best fit to the data. There are various statistical approaches to estimate this parameter vector which are all summarized under the term probit analysis. In the following a brief summary of those methods most commonly subsumed under the term probit analysis is given. Instead of using a lot of statistical formulae, an empirical data set is chosen to illustrate the different approaches which range from simple graphical solutions over regression techniques to the maximum likelihood principle.

The data set used for illustration consists of status quo data on menarche sampled from 2796 girls aged between 10.01 and 18.32 years during the *First Bremerhaven Growth Survey* carried out in 1979/80 (see also Ostersehlt and Danker-Hopfe in this volume). The distribution of pre- and postmenarcheal girls by half year age groups – with the age displayed being the midpoint of the underlying interval – is shown in *Figure 3*. The youngest postmenarcheal girl in the sample was 10.77 years old, the oldest premenarcheal on the other hand was 17.24 years which is a quite exceptional event (see Ostersehlt and Danker-Hopfe 1991), the next oldest premenarcheal girl was 16.22 years old. We will refer to this exceptional observation again a little later. Since sample size is comparatively large further results are based on a subdivision of the age variable by 0.2 years.

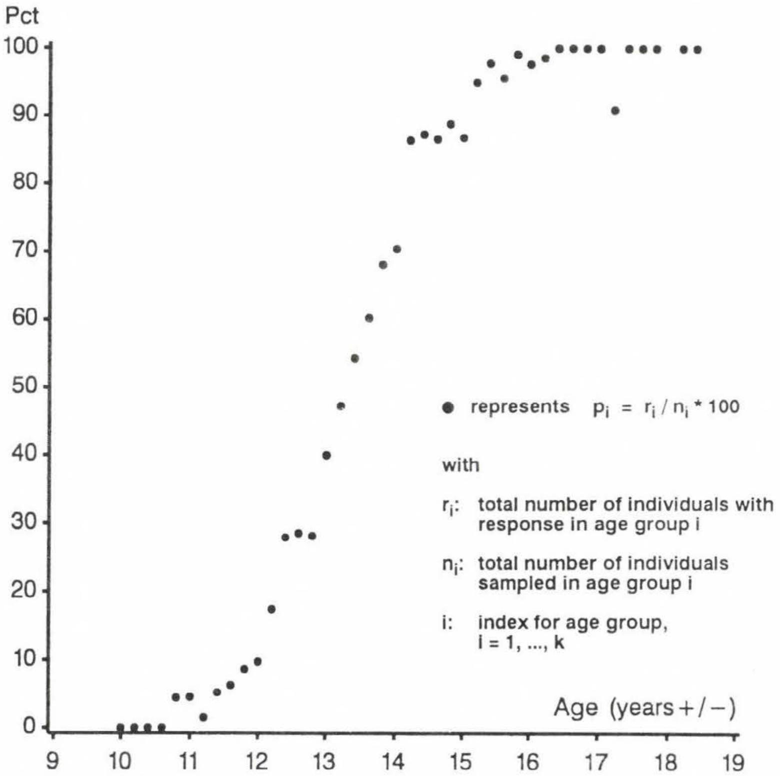


Fig. 2: Empirical distribution of postmenarcheal girls — age grouped in 0.2 year intervals

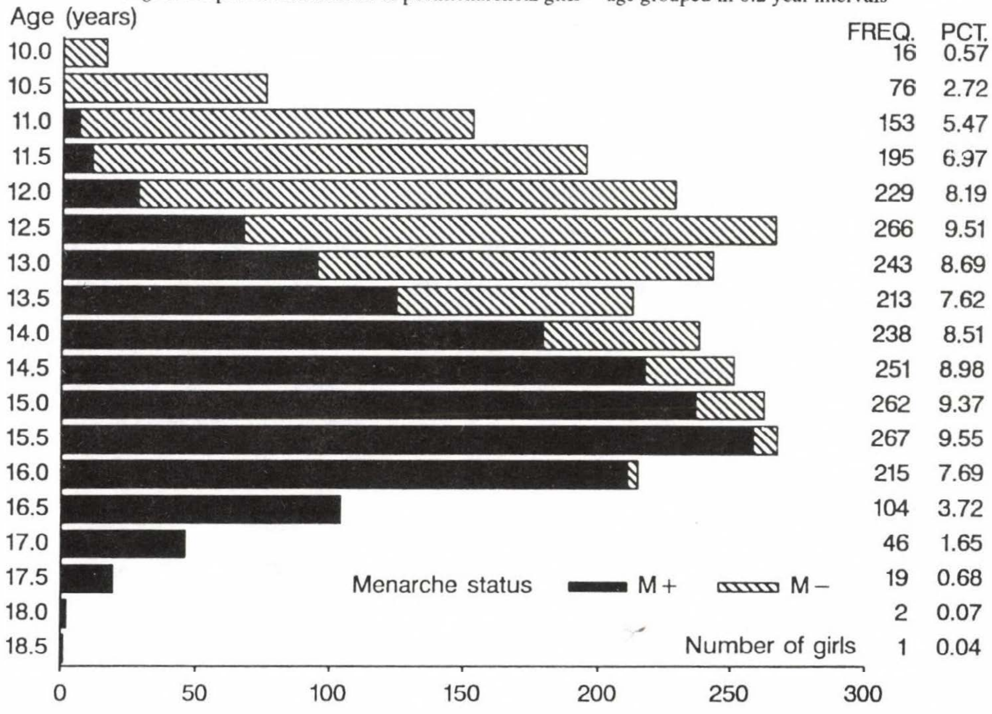


Fig. 3: Age structure of the sample

Transformation

The basic step when estimating the parameter vector (μ,σ^2) is the probit transformation. Probit transformation transforms the sigmoid curve (1) into a linear one (2), where the vertical axis represents the transformed probability of trait occurrence and where the horizontal axis – as before – represents the age variable. The transformed dependent variable is the so-called *probit* (probability unit). For a detailed discussion of the single steps of axis transformation as well as of probit analysis in general see e.g. Finney (1971), Weber (1980), Unkelbach and Wolf (1985) and McCullagh and Nelder (1989).

$$F(x) = \frac{1}{(\sigma\sqrt{2\pi})} \int_{-\infty}^{x} e^{(-1/2)[(t-\mu)/\sigma]^2} dt \qquad (1)$$

$$y = a + bx \qquad (2)$$

The functional relationships between the parameter vector (μ,σ^2) and the parameter vector (a, b) of the linear equation defining the probits are demonstrated by equations (3) and (4), where the '5' is a historical relict, introduced with the intention to avoid computations with negative numbers.

$$\sigma = 1/b \qquad (3)$$

$$\mu = (5-a)/b \qquad (4)$$

Estimation Techniques and Results

The most simple approaches to estimate the parameters a and b, and hence μ and σ^2, are graphical ones. Graphical approximations can be carried out on so-called probability paper. As shown in *Figure 4*, the observed frequencies of postmenarcheal girls by age may simply be plotted and a "regression" line may be fitted to these data by eye. A rough estimate of the mean can be obtained by raising a horizontal line from 50% until it intersects with the eye fitted "regression" line and then reading the age on the linear age scale. Since it is known that for normally distributed traits approximately 68% of the observations lie within the interval $\mu \pm \sigma$ one might get an estimate of σ by raising horizontal lines from approximately 84% and 16% until they intersect with the eye fitted "regression" line and then reading the corresponding ages for $\mu + \sigma$ and $\mu - \sigma$ at the age scale. One will get estimates of σ by simple subtraction. It should be noted, however, that the results obtained are highly subjective since they entirely depend on the "regression" line fitted by eye. If probability paper is not available one might directly transform frequencies into probits, using a table which is to be found in every good statistical textbook or in a collection of statistical tables (Fisher and Yates, 1963, Finney, 1971). Then a graphical estimation can be performed using ordinary millimeterpaper.

Since it is expected that the plot of probits of postmenarcheal girls by age can be approximated by a straight line the next step of complexity or towards more accuracy would be to apply regression techniques (see *Figure 5*). There are 0.5n!/[2(2–n)!] straight lines which can be fitted to the scatter of probits. Every two points define uniquely a regression line. Every pair of coordinates, that is ages and their corresponding probits, can be chosen to get estimates of the parameters a and b. But again the problem is that the results entirely depend on the subjectivity of selecting the points.

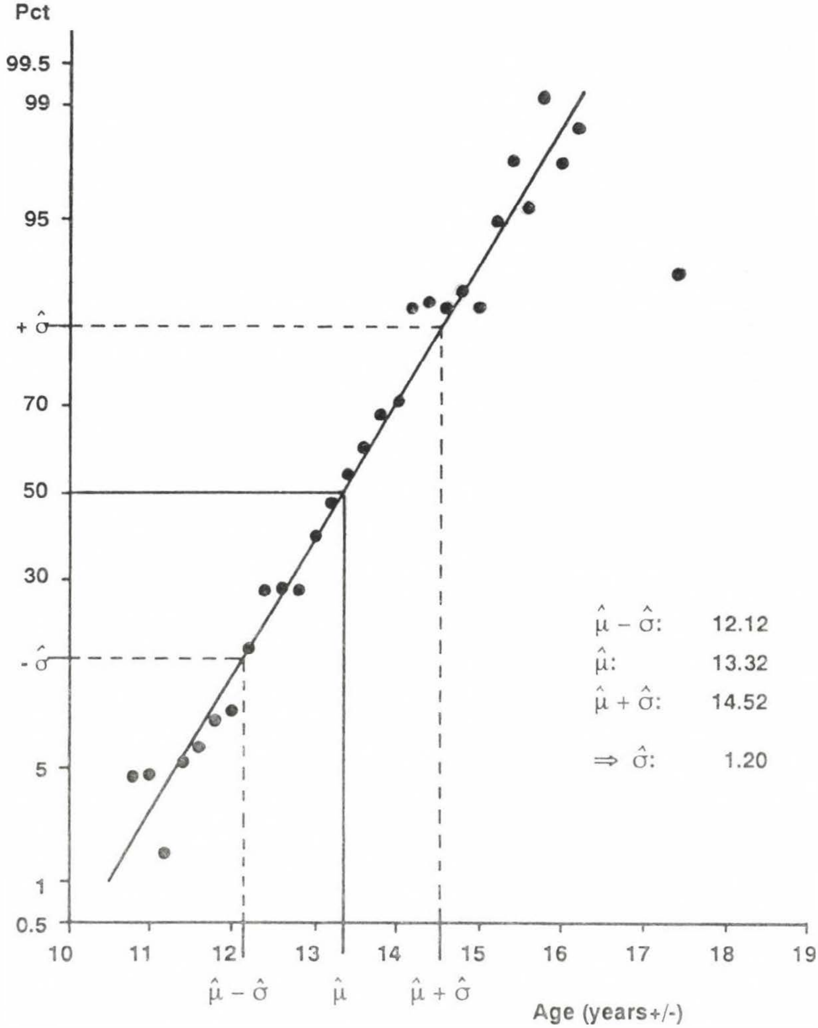
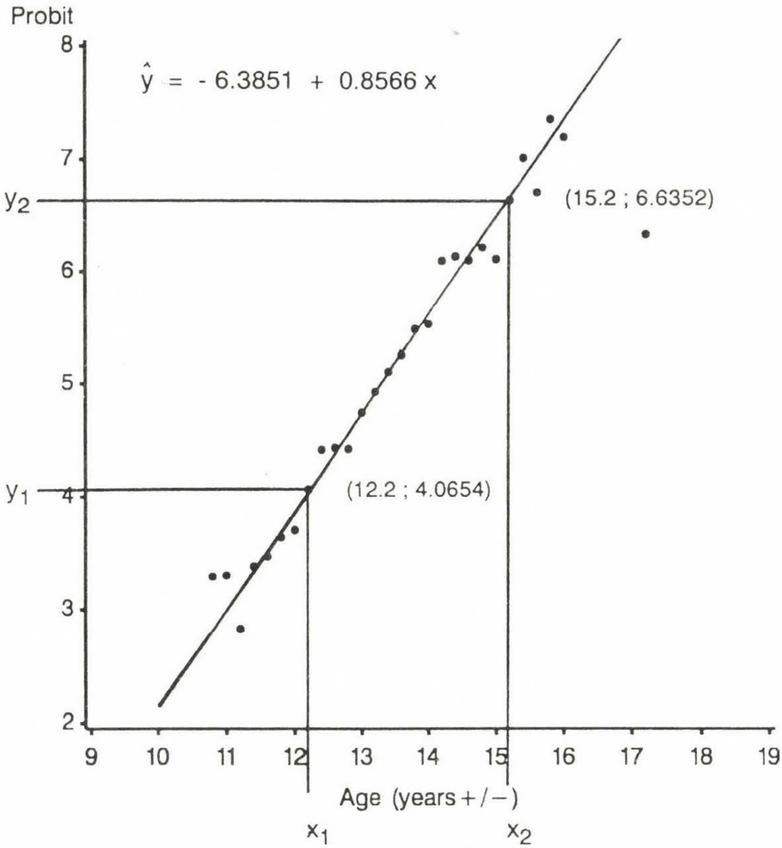


Fig. 4: Estimation of μ and σ by fitting a straight line by eye



estimation of the slope:	$b = (y_2 - y_1) / (x_2 - x_1)$
$\Rightarrow$ estimate of σ:	$\hat{\sigma} = 1 / b \quad = 1.17$
estimation of the intercept:	$a = y_1 - bx_1$ or $a = y_2 - bx_2$
$\Rightarrow$ estimate of μ:	$\hat{\mu} = (5 - a) / b \quad = 13.29$

Fig. 5: Estimation of μ and σ by fitting a straight line through two selected points

This approach – estimation by selecting two points – produces a lot of numerically different estimates of a and b, but how to find the ones which fit the empirical data best? The usual criterion for the best fit is that the sum of squares of the differences between observed and expected probits is minimal, which leads to the *least-squares method* of estimation where a and b are estimated according to equations (5) and (6):

$$b = \frac{\Sigma x_i y_i - \bar{y}\, \Sigma x_i}{\Sigma x_i^2 - \bar{x}\, \Sigma x_i} \qquad \begin{matrix} (\bar{y} = \Sigma y_i/k) \\ (\bar{x} = \Sigma x_i/k) \end{matrix} \tag{5}$$

$$a = \bar{y} - b\bar{x}. \tag{6}$$

One of the main drawbacks using simple least-squares regression techniques in this context, however, is that the method is based on the assumption that the variances of the dependent variable (y_i) are equal for all values of the independent variable (x_i), an assumption which is not met by the underlying data. To avoid the error introduced by unequal variances a *weighted regression analysis* should be performed with the reciprocal variances being the weights. This leads to a problem of nonlinear optimization, which can only be solved by iterative estimation techniques.

A method which asymptotically leads to the same estimates is the maximum-likelihood principle. *Maximum-Likelihood estimation* is a universal technique to estimate unknown parameters from empirical (observed) data if – and this is essential – the model of distribution is known. To understand the principle of this estimation technique some notions and basic ideas will briefly be repeated. Let

$$p_i = r_i / n_i \tag{7}$$

be the frequencies with which a specific response occurs at age x_i. The number r_i of responses given n_i trials follows a binomial distribution, that means the probability that responses have already occurred in r_i of n_i individuals is defined by equation (8).

$$p_i = \binom{n_i}{r_i} p_i^{r_i} (1 - p_i)^{n_i - r_i} \tag{8}$$

Since it can be assumed that the observations in the different age groups are independent and identically distributed the probability of the result of the whole experiment is the product of the single probabilities:

$$L = \prod_{i=1}^{k} p_i = \prod_{i=1}^{k} \binom{n_i}{r_i} p_i^{r_i} (1 - p_i)^{n_i - r_i} \tag{9}$$

This equation is called the likelihood function, where L is considered to be a function of p_i given r_i and n_i.

Assuming that the observed result is most likely, the unknown parameters will be estimated according to those values which make the observed or empirical data most likely, again leading to a problem of optimization. We have to look for the maximum of the function, which can be determined by estimating the zeros of the first partial derivatives. To estimate p in this context p and individual age have to be related, where p_i is a function of age x_i. From the literature it is known that most of the qualitative events dealt with in auxology are normally distributed traits, so it is reasonable to assume that p_i can be obtained from the cumulative normal distribution function mentioned earlier. But, this is the place where different distribution models (e.g. logistic distribution, Gompertz distribution etc.) can be used.

Estimation of μ and σ in this relationship which means to maximize L by a choice of μ and σ, again requires iterative techniques and the use of computers is recommended. There are several commercial statistical software packages which include probit analysis by the maximum-likelihood principle. We used SAS and got the maximum likelihood estimates shown in *Table 1* together with the results obtained by application of the other methods.

Table 1. **Results of probit analysis by different estimation techniques and results of the likelihood ratio test of goodness-of-fit**

Estimation technique	μ [years]	σ [years]	χ^2 (40)	p
Graphical approach on probability paper	13.32	1.20	34.50	0.7155
Regression analysis: regression line defined by two coordinates	13.29	1.17	34.80	0.7030
Regression analysis unweighted least-squares estimates	13.35	1.33	47.14	0.2037
Regression analysis weighted least-squares estimates	13.32	1.18	34.68	0.7080
Maximum-likelihood estimates	13.30	1.19	34.24	0.7264

Except for the estimates obtained by the unweighted least-squares regression method the means exhibit comparatively little variation. This is primarily due to the large sample size and detailed subdivision of the age scale. If sample sizes are small and age classification is rough the results will certainly be more diverging. Differences between the estimates of the standard deviations obtained by the different methods seem to be more pronounced.

Discussion

The quality of the different estimates must be discussed. There are at least two criteria which can be used for this purpose. The first assessment of the estimates is based on their standard errors. Since these, however, are not available for the first two methods the second criterion, which can be used with all the methods of estimation mentioned, will be used in this context. This is a test of goodness-of-fit of the empirical data to the distribution defined by the estimated parameters. There are two main possibilities: the first is to use Pearson's ordinary χ^2-test (10):

$$\chi^2 = \sum_{i=1}^{k} (N_{oi} - N_{ei})^2 / N_{ei} \qquad (10)$$

with:

N_{oi} : observed number of postmenarcheal girls in the ith age group
N_{ei} : expected number of postmenarcheal girls in the ith age group, $N_{ei} = n_i * \hat{p}_i$;
k : number of age groups.

and the second is use of the likelihood-ratio test (11):

$$\chi^2 = -2 \log 1 \sum_{i=1}^{k} n_i \left(p_i \log \frac{p_i}{p_i} + (1 - p_i) \log \frac{1 - p_i}{1 - p_i}\right) \qquad (11)$$

with:

k : number of age groups
n_i : sample size in the ith age group
p_i : observed relative frequency of postmenarcheal girls in the ith age group
p_i : expected relative frequency of postmenarcheal girls in the ith age group – derived from the model.

Application of both tests to the data yielded the following results:

Pearson's χ^2	$\chi^2_{(40)} = 189.53$;	$p < 0.001$;
likelihood ratio test:	$\chi^2_{(40)} = 34.24$;	$p = 0.7264$.

Focussing on the probability of error for rejection of the hypothesis – that the data was generated by a normal distribution – it is seen that according to Pearson's χ^2-test the fit seems to be very bad – leading to rejection of the model – while the likelihood ratio test reveals a comparatively good fit. How can these contrasting results be explained? Both tests are based on the same empirical data and the same ML parameter estimates. Here the original data of pre- and postmenarcheal girls have to be recalled. In our sample there was one girl aged 17.24 years who had not yet experienced menarche. This single girl leads to the extremely high Pearson's χ^2-statistic. Due to an expectation which is close to zero, age group 17.2 contributes a value of 164.15 to the total χ^2, that is more than 86% (86.61%), while the contribution of this age group to the likelihood ratio χ^2 is only 8.33, which amounts to 24.33%.

The data thus demonstrate that as far as rare events are included in a data set, ordinary Pearson's χ^2-test might be quite misleading. To avoid biases by rare events the likelihood ratio test of goodness-of-fit is to be preferred. The results of the likelihood ratio test are also summarized in *Table 1*. The error probabilities indicate that simple least squares regression leads to estimates which do not fit the empirical data very well. On the other hand ML-estimation of the parameters leads to the best fit as indicated by the highest error probability which is almost 73%.

Summarizing the results, ML estimation or weighted regression analysis is recommended because they are defined on adequate model assumptions and allow assessment of precision. Furthermore they are free of subjective effects which is not true for graphical and related procedures. And finally a goodness-of-fit test should be performed, preferably the likelihood ratio test because of its robustness against effects of rare events, to get an idea about the fit of the emprical data to the model assumptions.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 17 July, 1991.

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Anthrop. Közl. *33;* 123-127. (1991)

ON THE INTERPRETATION OF THE CURVES OF MENARCHE/OIGARCHE

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Abstract: *With respect to the advantages of the widespread computer technique, the authors propose to calculate the percentile values of menarche and oigarche data. They interpret their percentile values based on their "Hungarian National Growth Study" (Eiben — Pantó 1881, 1986, 1987/88), by comparing them with those of other studies. Thereafter they give a transformed formula of the curve's equation which makes possible the obtaining of the same result by a very simple graphical technique.*

Key words: *Menarche/oigarche curves; Percentiles, Corresponding "weight" of the relative rate of the cohort; Hungarian National Growth Study.*

Introduction

The earliest investigations of girls' puberty were based on the retrospective method. The adult women were asked about the date of their menarche, and the mathematic average of the given ages was calculated. Using the *status quo* method for data-collection, the above-mentioned way is unfeasible. To evaluate data, the regression method of probit analysis was recommended (Weber 1957, Finney 1962) which was elaborated for the investigation of quantifiable effects. This was based on the realization that time can function as a dose. As "an answer" for the increasing doses, i.e. for the effect of advanced time, onset of puberty (menarche/oigarche) in pubertal-aged individuals of the population appears at increasingly larger rates.

In the age of computers, there is no problem to using this method and to calculate not only the median (the 50th percentile value) but all the other percentiles which provide us with some important information about the S-shaped curve.

Material and Methods

The mathematical process was carried out on the basis of the explicit form of the curve:

$$Y = \frac{100}{1 + e^{-A(x + C)}}$$

From the form of the function it can be seen that the numeric value of the constant C gives the value of the median immediatly and the constant A characterizes the hollowness/roundedness of the S-shaped curve (c. f. Burrel et al. 1961).

Results and Discussion

With the help of the above-given function the authors carried out calculations on several samples. Their percentile values are given in *Table 1*. As it can be seen, not only the median value but also the *percentiles* were determined: One can determine any age belonging to any optional *yes-percent*. The authors recommend for practical purposes the 3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles.

Table 1. **Menarche median and percentile values of different samples**

Author / **Sample**	**3**	**10**	**25**	**50**	**75**	**90**	**97**
	Percentiles						
Van Wieringen et al. 1971 The Netherlands N = 2079	11.17	11.86	12.52	13.33	14.11	14.72	15.38
Eiben 1972 Western Hungary N = 15229	10.53	11.48	12.29	13.09	13.90	14.71	15.66
Łaska-Mierzejewska et al. 1982 Poland Urban (Warsaw) N = 5546	10.47	11.31	12.04	12.76	13.48	14.20	15.04
Rural N = 7771	10.96	11.85	12.61	13.96	14.14	14.91	15.80
Bodzsár 1991 Bakony (Western Hungary) N = 1319	10.59	11.36	12.03	12.69	13.36	14.02	14.79
Farkas 1986 Southern Hungary N = 24478	10.50	11.33	12.04	12.76	13.47	14.18	15.01
Eiben — Pantó 1986, 1987/88 Hungary (HNGS) N = 12702	10.65	11.43	12.11	12.78	13.46	14.14	14.92

With this computer-oriented elaboration each point was taken into account with a corresponding *weight* of the relative rate of the given age-group. (This had to be a natural requirement in all exact regression studies!)

The *median* (or any other age corresponding to any other percent values) can be *determined also in that case*, even if there are no applicable data in the vicinity of the percent value in question (e.g. because of some *practical insufficiency*). It is mathematically evident that the total curve in question (including the diverging sides of the S-shaped curve) can be determined by its minimum two, arbitrary points. Knowledge of more points means a greater accuracy, of course.

A further possibility arises from the above mentioned considerations, i.e. one can get a linear form by a simple mathematical transformation of the function of the curve:

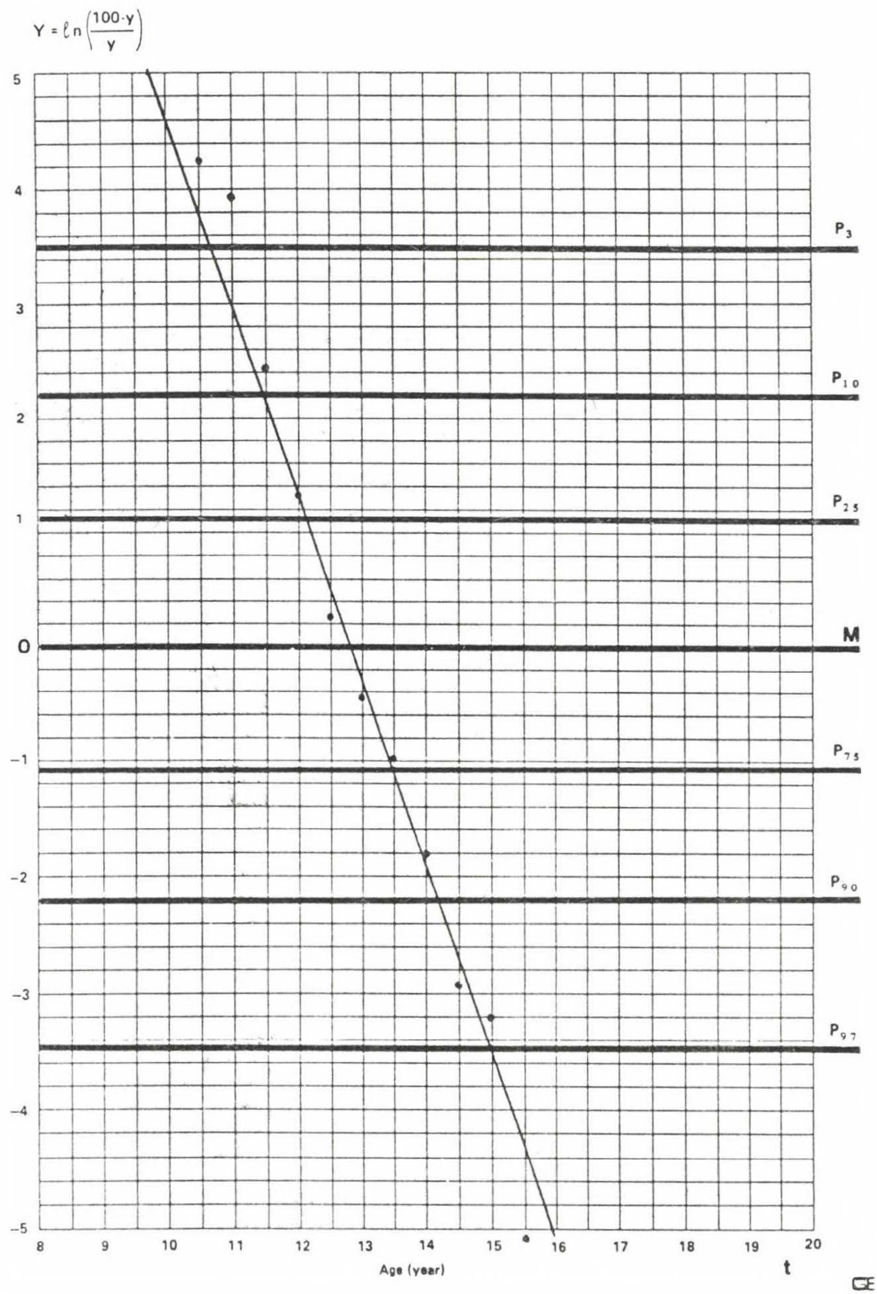

Fig. 1: Median and percentile values of menarcheal age in Hungarian girls in the 1980s, based on the Hungarian National Growth Study (Eiben — Pantó 1986, 1987/88).

$$\ln \frac{100 - Y}{Y} = -Ax - AC$$

If one plots the expression $\ln \frac{100 - Y}{Y}$ as a function of age (x), one gets a heap of points spread around a straight line. Now, one can use a linear method (which is more simple mathematically, of course). An obvious advantage of a linear description is that in an expediently designed evaluation diagram one can easily get the median (50th percentile) and the percentile values (*Fig. 1*).

A quick and simple evaluation can be performed even by a ruler. In this case, however, one has to give up exactness of *weighting*.

Herewith we publish the basic data of the Hungarian National Growth Study's sample (Eiben – Pantó 1981, 1986, 1987/88) of which the number of elements was N = 39035. The number of girls in question between the ages 9 and 18.5 years was N = 12719. Out of this number 7232 gave the answer *yes* and 5487 the answer *no* (*Table 2*).

Table 2. **Number of girls investigated and percent values of menstruating girls ("yes%") of the Hungarian National Growth Study (Eiben — Pantó 1986, 1987/88) and the percentile values of age at menarche (N = 12702)**

Age (year)	N	"Yes%"
9.0	704	0.14
9.5	621	—
10.0	638	0.15
10.5	653	1.37
11.0	701	1.84
11.5	669	7.92
12.0	689	21.19
12.5	701	42.79
13.0	689	60.08
13.5	659	72.98
14.0	658	85.86
14.5	751	94.94
15.0	792	96.08
15.5	655	99.38
16.0	737	99.05
16.5	672	99.55
17.0	626	99.68
17.5	508	100.00
18.0	420	99.52
18.5	159	99.37

Percentile	Age	–3 SD	+3 SD
3	10.6460	10.6431	10.6488
10	11.4329	11.4295	11.4362
25	12.1089	12.1051	12.1127
50	12.7849	12.7807	12.7891
75	13.4609	13.4563	13.4655
90	14.1369	14.1319	14.1420
97	14.9238	14.9183	14.9294
A =	1.62518	1.62615	1.62409
B =	12.7849	12.7807	12.7891

These data were elaborated with the above-described (computer oriented) regression analysis. This gave a median m = 12.78 year (*Fig. 1*).

The next step in elaborating the menarcheal/oigarcheal data seems to be the investigation of the question: how the median (C) and the other percentile values and how the hollowness (A) of the curve changes with the different biological and/or socioeconomical endowments.

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Acknowledgement: The authors wish to thank Mr Lajos Kecskés and Dr Gyula Kluge for their assistance and discussion.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 15 June, 1991.

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Anthrop. Közl. *33;* 129–132. (1991)

RELIABILITY OF HEIGHT PREDICTION METHODS IN SHORT STATURE CHILDREN

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Abstract: *According to our former studies on height prediction in short children the Bayley – Pinneau (BP) and Tanner – Whitehouse (TW2) methods were accurate while Roche – Wainer – Thissen (RWT) estimation proved less correct. We focused on the possible nature and cause of this inaccuracy. RWT predicted values were ranged into 3 groups (underestimated – averaged – overestimated) and related chronological age (CA), bone age (BA) were analyzed. The same was carried out in the values calculated by BP and TW2 methods. We found underestimation in 9 of 44 cases predicted by RWT, both their CA and BA were significantly lower compared with that of the averaged group. In the total values underestimated by the different methods the CA and BA were also significantly lower in RWT group compared with that of the BP group. Taking account of these results it seems the less reliability of RWT method is limited to CA under 12 years, BA under 14 years.*

Key words: *Short stature; Height prediction; Chronological age; Bone age.*

Introduction

There are several methods for prediction adult height using anthropometric data, variables that can be observed at a single examination. Most favourable are the methods of Bayley – Pinneau (BP), that of Roche – Wainer – Thissen (RWT) and that of Tanner and Whitehouse (TW2). They can help us to differentiate children with height below 3rd percentile: who can get benefit by growth promoting therapy and who do not. Controlling the effect of any treatment height prediction would be also useful. It was revealed in the course of our former comparative studies in short stature children (Muzsnai and Péter 1989) that BP or TW2 methods were accurate under certain circumstances (e.g. in growth hormone or anabolic steroid treatment) while RWT estimation proved to be less correct. We focused on our attention whether the later had a trend to over- or underestimate adult height, or it depended on the chronological age, perhaps on the bone age.

Subjects and Methods

We selected patients referred for short stature to the pediatric endocrinology, boys and girls who had already achieved adult height. Children's height was around the 3rd percentile at the time of the first visit according to both the Tanner – Whitehouse (1976) and Eiben – Pantó (1986) growth standards. Predicted height were calculated in 179 cases by three methods: developed by Bayley and Pinneau (1952), Roche, Wainer and Thissen (1975), Tanner and al. (1983) summarized on the *Table 1.* Bone age was determined for BP and RWT methods from the Greulich – Pyle Atlas (1959), while the TW2 prediction has an own bone age assessment system (Tanner et al. 1983). Accepting ± 1 cm to final height predicted values were ranged into 3 groups: underestimated, average, overestimated and related chronological age (CA), bone age (BA) were analyzed. Data were compared by Student *t* test.

Table 1. **The validity range (year) and parameters used for the calculation in the height prediction***

	BP	RWT	TW2
Boys Girls	7 — 18.5 6 — 18.0	1 — 16 1 — 14	6 — 18.5 — 5 — 14.5 —
1.	Height	Recumbent lenght	Height
2.	GP bone age	GP bone age	T bone age
3.	—	Weight	Chronological age
4.	—	Midparent stature	—

* BP : Bayley — Pinneau method
RWT : Roche — Wainer — Thissen method
TW2 : Tanner — Whitehouse method
GP : Greulich — Pyle Atlas
T : Tanner Atlas

Results and Conclusion

Groups with underestimated, average and overestimated height obtained by the different methods and related chronological age are shown on the *Figure 1*. Under the bars the number of cases were indicated. We found underestimation in 9 cases from the 44 cases of RWT prediction, their mean CA (11 year) was significantly lower ($p = 0.02$) compared with that of the average group (14.4 year). Similar differences were not found either in the BP or in the TW2 estimated groups.

On the *Figure 2* we give the bone age of the formerly separated groups; almost the same situation can be seen. There was also a significant difference ($p = 0.02$) between the RWT underestimated group (8.7 year) and the average group (12.6 year), but not between the others. In general the BA was retarded in all groups.

The *Figure 3* shows the CA and BA only of the underestimated groups. Comparing the CA or BA in the total number of underestimated groups by the different methods, both were significantly lower (CA – $p = 0.04$ and BA – $p = 0.01$) in RWT group compared with that of the BP group.

Considering that both RWT and BP prediction methods use the Greulich – Pyle Atlas in the assessment of the bone age we conclude: the less reliability of RWT method for prediction of adult height is connected with the age, it is limited to chronological age under 12 years, bone age under 14 years. This suggests that the age validity range of the RWT method (Table 1) would be modified.

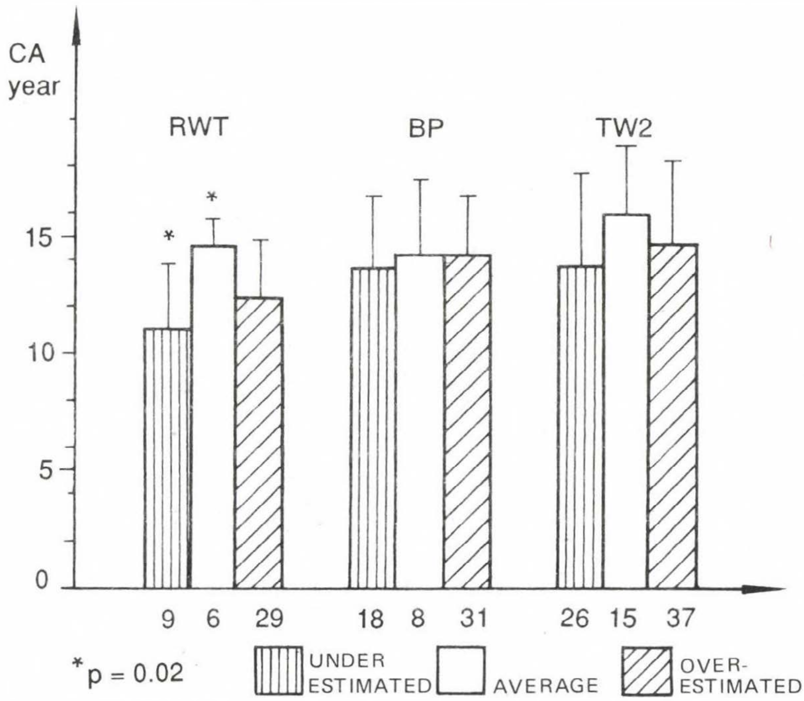

Fig. 1: Underestimated, average, and overestimated height obtained by the different methods and related to chronological age

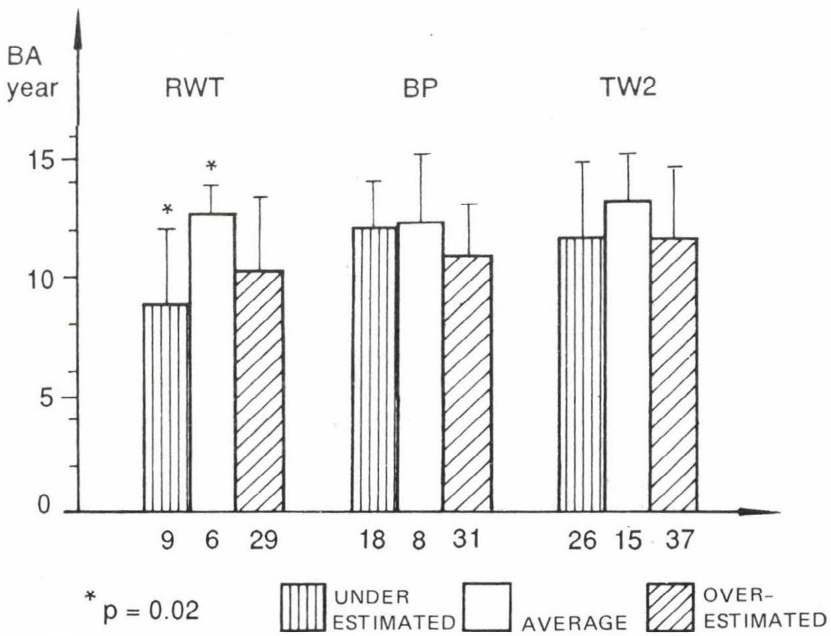

Fig. 2: Underestimated, average, and overestimated height obtained by the different methods and related to bone age

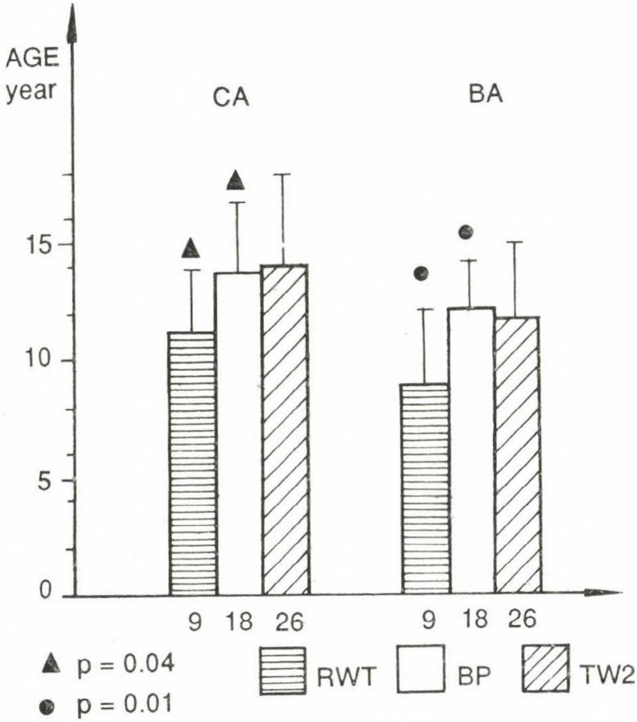

Fig. 3: Chronological age and bone age in underestimated groups

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991;
Received 1 August, 1991.

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Anthrop. Közl. *33;* 133–137. (1991)

RELATIONSHIPS BETWEEN DEVELOPEMENT OF SECONDARY SEX CHARACTERISTICS AND SOCIO-ECOLOGICAL FACTORS

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Abstract: *The age at menarche in Hungarian girls was examined between 1981 and 1984. More than 32 000 data of girls were collected by status quo method. The menarche median (Me = 12.79 year) was determined by probit analysis based on 24 478 data.*

The data derive from 10–15 year old girls concerning to the development stage of pubic hair, axillary hair and breast (after Tanner).

The fifty percent level of the adult stage of secondary sex characteristics was determined by scales (Schwidetzky). The basic data was valued according to the socio-ecological factors, like: number of siblings, order of birth, education and occupation of parents etc.

The details of the results from more than 16 000 girls is shown in this paper.

Key words: *Pubic hair; Axillary hair; Breast; Socio-ecological factors.*

Introduction

One of the most important part of one's extrauterin life is the puberty. Its beginning is marked by appearance of the development of the secondary sex characteristics. However, we have acceptable methods to study these facts (Tanner 1962) but collecting data like this cannot be carried out without problems at every population.

These problems may be caused by difficulties in social conventions for example. In Hungary we have only few data concerning the secondary sex chasracteristics of the youth and most of these observation based on girls' data (Jónás et al. 1968, Farkas 1969, 1986, Örley 1975, Borsos et al. 1977, Borsos 1982, Bodzsár 1983).

These things motived us to study the relationship between the development of secondary sex characteristics and the socio-ecological facts.

Material and Methods

Between 1981 and 1984 in Hungary more than 32 000 data of schoolgirls were recorded by status quo method with the help of a questionnaire. The research aimed at examining the age of menarche and its relation with the socio-ecological facts. In the course of this work body height, body weight, normal circumference of chest and bicristal breadth were measured, too (Farkas 1986). This research is also spreaded to the examination of the development stages of pubic hair, axillary hair and brest described by Tanner using point scale evaluation method. The data were converted into a 12 point scale after Schwidetzky (Grimm 1966) than they were valued by R–40 computer using the Osiris program. Our purpose was to examine the age when the development of secondary sex characteristics are the 50 percent of the full developed stages. It is equivalent of 6 point on the scale.

This research mainly refers to the 10–14 year old girls and it is also considers some 7–9 year old girls. The 15 year old girls in our sample are the overaged of primary, as we didn't examine the high school girls.

We tried to classify the socio-ecological facts exactly, so for example at the occupation of parents we relied on a work dealing with classification of the occupation occuring in Hungary. In this respect we have 7 categories at fathers and 8 at mothers.

Our ssample includes 6722 menstruated and 9353 non-menstruated 10–15 year old girls. These counts could be different at the certain facts because doubtful or false data were disqualified at the evaluation.

Results

The menarche median of this sample is Me = 12.79 years.

Table 1 shows medians of secondary sex characteristics (further SSC) regarding the absence and presence of menstruation. The table unambiguously shows that the median of menstruated girls are lower, so the development of their SSC begins earlier then that of the non-menstruated girls. The difference is about 3 years.

Table 1. **Development of SSC according to the puberty**

SSC	Menstruated (M_e)	Non-menstruated (M_e)
Breasts	10.40 years	13.74 years
Pubic hair	10.50 years	13.69 years
Axillary hair	10.86 years	14.05 years

On the *Table 2* the medians of SSC can be seen according to the socio-ecological factors. There are no significant differences between these medians as each categories were divided into smaller categories and these smaller groups' medians were calculated at first than we based on the means of these medians. As the number of cases are about the same at every factor, the final results are similar.

Table 2. **Development of SSC according to socio-ecological factors**

Socio-ecological factors	Pubes (M_e)	Axillary hair (M_e)	Breasts (M_e)
Education of mother	12.50	12.51	13.20
Education of father	12.50	12.51	12.69
Occupation of mother	12.52	12.50	12.41
Occupation of father	12.49	12.55	12.41
Size of girls' domicile	12.50	12.52	12.42
Number of living siblings	12.59	12.69	12.49
Order of birth	12.49	12.58	12.74
Last school report	12.51	12.52	12.42

But there is a more important fact that in case of medians of individual factors do not show the same change. For example: according to the education of parents or the order of birth the development of SSC is arranged as follow: breast, axillary hair and pubic hair, while regarding the occupation of mother the order is pubic hair, axillary hair and breast.

As the sample derives from the 10–15 year old girls and the development of SSC appears at earlier ages the median cannot be calculated in detailed classification. That's why we based on the average points of the SSC development at the comparison.

The *Table 3* shows the change of axillary hair development depending on the occupation of parents. It can be seen that there are no significant differences between the girls having parents with different occupation, however the appearance of axillary hair can be put to an earlier age at the girls having manual worker parents, than at the girls whose parents have intellectuel jobs. It is the opposite of the occurrence of menarche.

Table 3. **Development of axillary hair according to the occupation of the parents (average points, according to Schwidetzky)**

Occupation of the parents	Father	Mother	Father	Mother
	menstruated girl		non-menstruated girl	
Industrial manual worker	8.41	7.91	3.89	3.67
Agricultural worker	8.57	7.85	3.74	3.91
Other manual worker	8.20	7.85	3.75	3.76
Intellectual (high educated)	8.96	8.35	4.09	4.42
Intellectual (second. educated)	8.58	8.03	4.01	4.00
Pensioner	7.48	7.53	3.30	3.69
Father/Mother died	8.04	8.76	3.97	3.74
Homemaker	—	7.17	—	3.78

The same holds in respect of the development of pubic hair (*Table 4*) and breasts (*Table 5*).

According to the parents' occupation we found a more expressed relation in the development of axillary hair: girls with lower educated parents start to develope earlier as it can be seen on the *Table 6*.

Without presenting any further tables we have the following experiences. Girls having worse school achievment have a later SSC appearance than those who have better school achievment.

We also made a survey on the development of the SSC concerning the size of settlements. Girls living in smaller populated settlements have a later SSC development than those of large places. However, in settlements with more than 100 thousands inhabitants a later appearance of the SSC were found, while in those of 50–100 thousands inhabitants it appeare sooner.

In our sample all the three SSC of the first born girls begin to develope earlier than in the case of second or third born girls; but the fourth born girls have lower points than the 3rd born girls. This order is similar to the order of menarche.

Table 4. **Development of pubic hair according to the occupation of the parents (average points, according to Schwidetzky)**

Occupation of the parents	Father menstruated girl	Mother menstruated girl	Father non-menstruated girl	Mother non-menstruated girl
Industrial manual worker	8.19	7.90	4.00	3.76
Agricultural worker	8.11	7.80	3.97	3.80
Other manual worker	8.27	8.02	3.95	3.68
Intellectual (high educated)	8.28	8.06	4.28	4.06
Intellectual (second. educated)	8.33	8.03	4.26	3.94
Pensioner	7.94	8.23	4.20	4.02
Father/Mother died	8.33	8.70	4.16	3.69
Homemaker	—	7.39	—	3.76

Table 5. **Development of breasts according to the occupation of the parents (average points, according to Schwidetzky)**

Occupation of the parents	Father menstruated girl	Mother menstruated girl	Father non-menstruated girl	Mother non-menstruated girl
Industrial manual worker	8.30	7.94	4.11	3.77
Agricultural worker	8.21	7.30	4.16	3.77
Other manual worker	8.36	8.05	4.10	3.93
Intellectual (high educated)	8.22	8.13	4.39	4.26
Intellectual (second. educated)	8.36	8.04	4.39	4.07
Pensioner	7.73	8.06	4.23	4.21
Father/Mother died	8.69	8.00	4.03	3.76
Homemaker	—	7.56	—	3.77

Table 6. **Development of axillary hair according to the educational level of the parents (average points, according to Schwidetzky)**

Education of the parents	Father menstruated girl	Mother menstruated girl	Father non-menstruated girl	Mother non-menstruated girl
Without primary	7.98	8.36	3.76	3.55
Primary school	8.18	8.39	3.93	3.76
Secondary school	8.43	8.27	4.39	4.02
Vocational school	8.55	8.76	4.22	3.96
University/College	8.88	8.92	4.39	4.03

When we examine the girls regarding the number of siblings we can see that the earliest occurance of the SSC is at those girls who have no siblings, and the more brothers of sisters they have the higher median or point we may find.

Summary

Based on the previous evaluation we can say the follows:

T'.e development of secondary sex characteristics precedes the physiological maturation. It corresponds the well-known experiments.

According to the socio-ecological factors the changes of the SSC are the same as at menarche.

In the cases of some factors the tendency of the change of menarche is different from the changes of the development of SSC (for example at the occupation of parents).

Using status quo method in 10–15 year old girls an unambiguous connection between the development of SSC and the socio-ecological status couldn't be established. The reason of this, in our oppinion, is that the development of SSC is more sensitive to the socio-ecological factors than the physiological maturation.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 1 August, 1991.

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Anthrop. Közl. *33;* 139–145. (1991)

PHYSICAL DEVELOPMENT AND MATURATION IN RELATION TO MENTAL PERFORMANCE IN GIRLS FROM AGE 10 TO 14

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Abstract: *Connection between indices of physical development, maturation and mental ability was studied in 354 girls aged between 10 and 14 years. Status of maturation was estimated by the stages of secondary sex characteristics and the onset of menarche. Mental performance was appraised by tests of non-verbal intelligence (Raven 1938) and creativity ("uncommon usage" and "the circles", Zétényi 1986).*

The IQ and creativity measures were compared in the girls of different maturational and physical developmental status but of the same age. Early maturers were found to perform better than late maturers in the intelligence test as well as in every index of creative ability. For IQ this difference was significant at all ages. The intelligence test scores of the subgroups with high fat content were lower than those for the low-fat subgroups. The differences were not significant but consistent. Girls with a high IQ were taller and heavier than their low-IQ peers. The girls with a low IQ were significantly fatter than those with a high IQ.

The hypotheses that physically early maturers are superior to late maturers in mental tests and that children with a high IQ have larger body dimensions at the same chronological age have been confirmed by these results.

Key words: *Adolescence; Early and late maturation; Physical development; IQ; Creativity; Body fat content.*

Introduction

Conflicting results have been obtained by the studies the central problem of which was if the maturation rate of physical, respectively mental development was similar (Boas 1941, Davidson and Gottlies 1955, Stone and Barker 1937, Westin-Lindgren 1979). One of the possible sources of this conflict may be that usually physical development and mental performance have been compared in children of the same chronological age, disregarding that they may represent very dissimilar levels of either physical or mental development (Inhelder and Piaget 1958, Tanner 1961).

Not neglecting this aspect, we approached the relationship between physical development and mental performance from two directions. Our questions were as follows.

– What difference in mental test performance is there between children of different maturation and physical development but of the same age?

– What difference in body composition and main dimensions is there between children of different IQ but of the same age?

Material and Methods

The study comprised 354 urban girls aged between 10 and 14. The following subgroups were formed for each age group: (1) girls before and after menarche; (2) girls with early and late maturation of breast and pubic hair; (3) girls of low and high relative body fat content; and (4) girls of low and high IQ.

In assessing secondary sex characteristics Tanner's (1961) suggestions were followed. The median stage of maturation was based on the intra-age-group distribution of the development of breast and pubic hair. Those found at stages below the median were termed late maturers, those above it were classified as early maturers.

Physical development was described by body mass, height and composition. Body density was estimated by Durnin and Rahaman's formula (1967) while fat per cent by Siri's method (1956). Low-fat girls were those one standard deviation below the mean while those one standard deviation above it were termed the high-fat subgroups.IQ was estimated by the adult version of the Raven perceptive non-verbal test (1938). The originality, flexibility and fluency factors of creativity were estimated by the methods of "uncommon usage and "the circles" (Zétényi 1986).

Subgroup differences were analyzed by the *t*-test at a 5% level of random error.

Results and Discussion

Post-menarcheal girls were found to have a higher IQ in every age group (*Fig. 1*).

Early maturers in respect of breast and pubic hair development also scored significantly better in the Raven test (*Fig. 2*).

While early mawturers had a higher score in all the three factors of creativity, only differences in originality and flexibility (estimated by the method of "the circles") were significant (*Table 1*).

Comparing the performance on the mental ability test of girls grouped on the basis of body fat percent, it was found that the Raven scores of the high-fat subgroups were consistently, though not significantly, lower than those of the low-fat ones (*Fig. 3*).

The second part of the study compared body height, mass and fat content as expressions of physical development in the low and high IQ subgroups of girls of similar age. The high-IQ subgroups were markedly taller and heavier (*Figs. 4* and *5*) except the 13-year-old ones' stature. Body fat content of the low-IQ subgroups was significantly higher, the only exception being the 12-year-old subgroup (*Fig. 6*).

Conclusions

This study of the relationship between physical and mental development has shown that physically earlier developing girls were also mentally more advanced. Conversely, the girls scoring higher in the mental tests had laarger body dimensions and also their body composition differed. High-IQ girls had greater fat-free and smaller fat mass.

During the adolescent growth spurt the growth rate of LBM is known to increase whereas the accumulated fat does not change (Forbes 1978). So, a possible explanation of the obtained results can be that there is an association between faster mental development and earlier physical development and maturation.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 1 August, 1991.

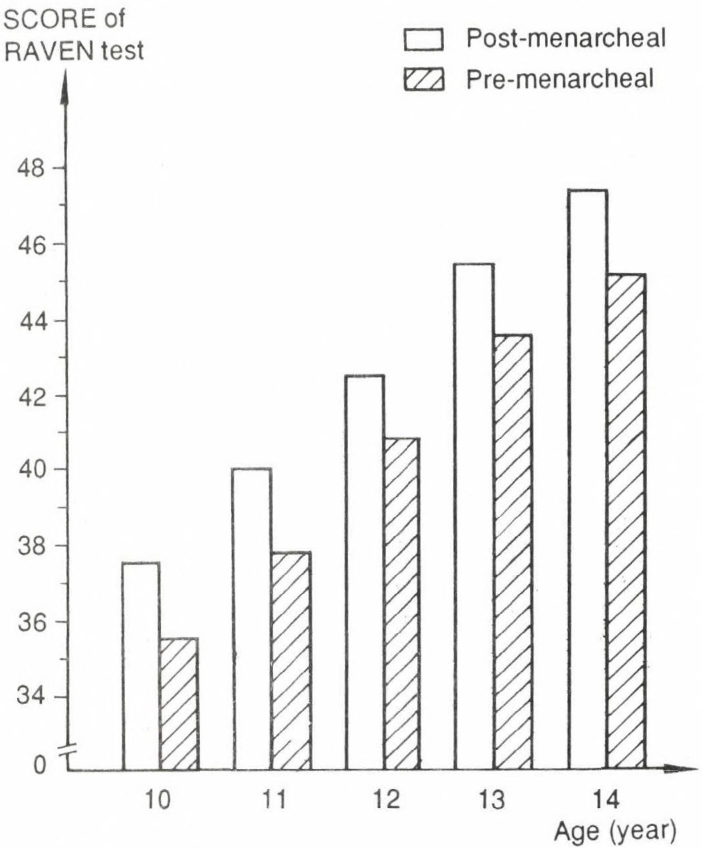

Fig. 1: Scores of Raven test in post- and pre-menarcheal girls

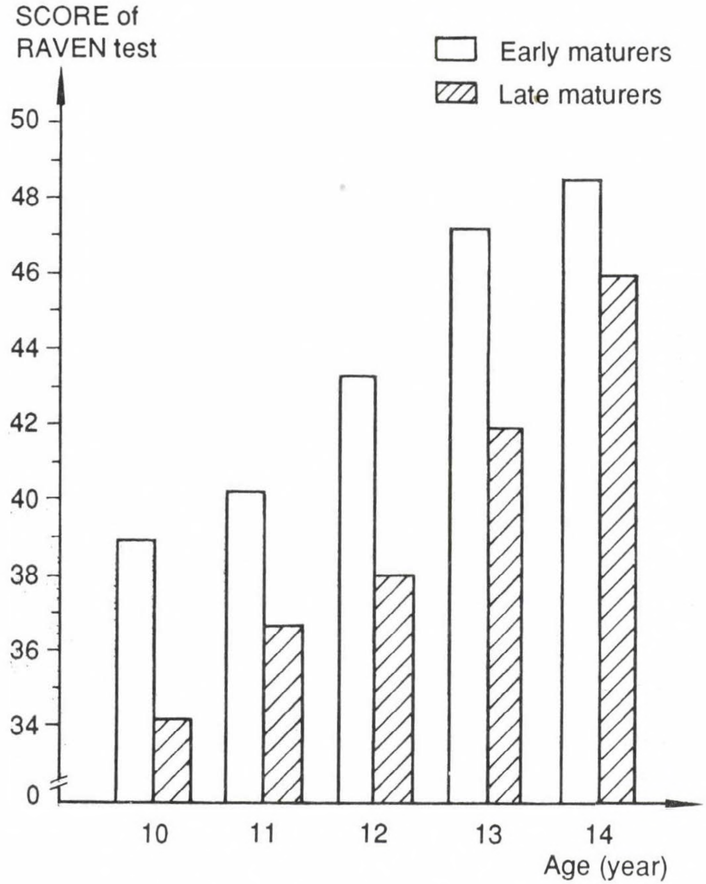

Fig. 2: Scores of Raven test in early and late maturers

Table 1. **Parameters of factors of creative ability**

Late maturers							Early maturers					
Flexibility		Fluency		Originality		Age	Flexibility		Fluency		Originality	
$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	(year)	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
						The method of the uncommon usage						
4.13	1.91	4.00	1.52	1.78	0.98	10	4.42	2.01	4.21	1.73	2.11	1.13
4.51	2.03	4.10	1.34	1.85	1.01	11	4.81	1.97	4.42	1.52	2.01	0.98
4.47	1.89	4.15	1.51	1.90	0.85	12	4.78	2.12	4.58	1.48	2.53	1.41
4.56	2.01	4.20	1.49	2.07	1.16	13	5.17	2.31	4.65	1.67	2.69	1.35
4.78	2.50	4.31	1.62	2.18	1.24	14	5.51	2.54	4.83	2.12	2.99	1.78
						The method of the circles						
7.90	3.75	7.40	2.57	3.30	1.94	10	8.51*	3.01	7.70	1.87	4.85*	1.81
8.01	4.01	7.67	2.41	3.75	1.86	11	9.38*	2.87	8.01	2.01	5.01*	1.76
8.37	3.99	7.90	2.77	4.01	2.15	12	11.51*	2.96	8.40	1.94	5.50*	1.99
8.45	4.17	8.11	2.88	4.15	2.05	13	12.00*	2.79	8.90	1.83	5.87*	1.84
8.60	4.45	8.25	3.14	4.23	2.31	14	12.65*	2.86	9.11	1.95	6.02*	1.79

*Significant level between two groups: $p < 0.05$

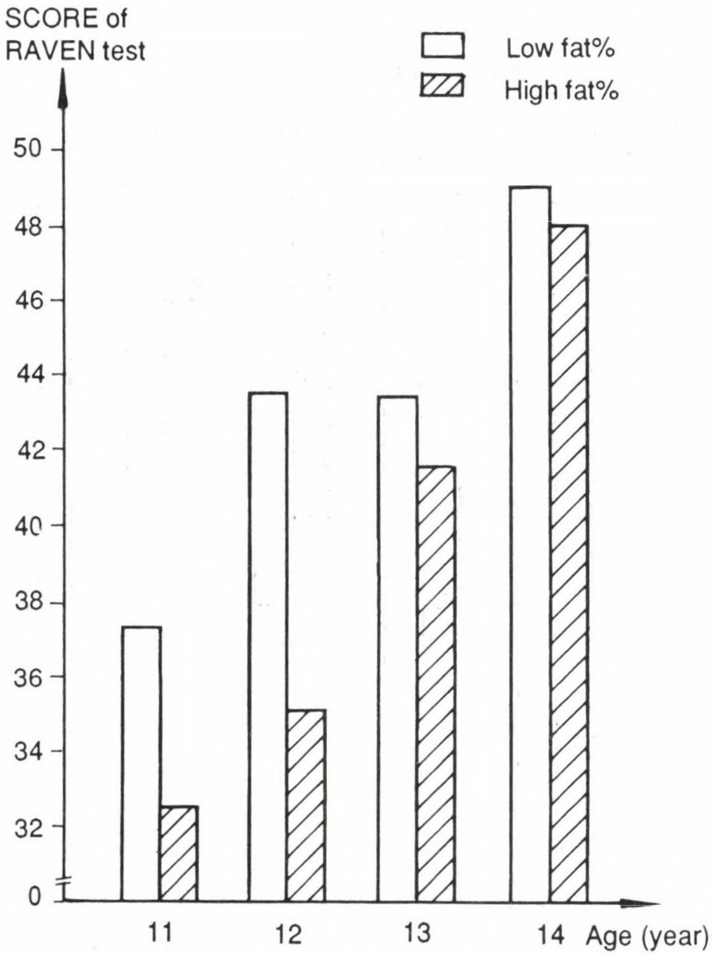

Fig. 3: Scores of Raven test in girls with low and high fat percent

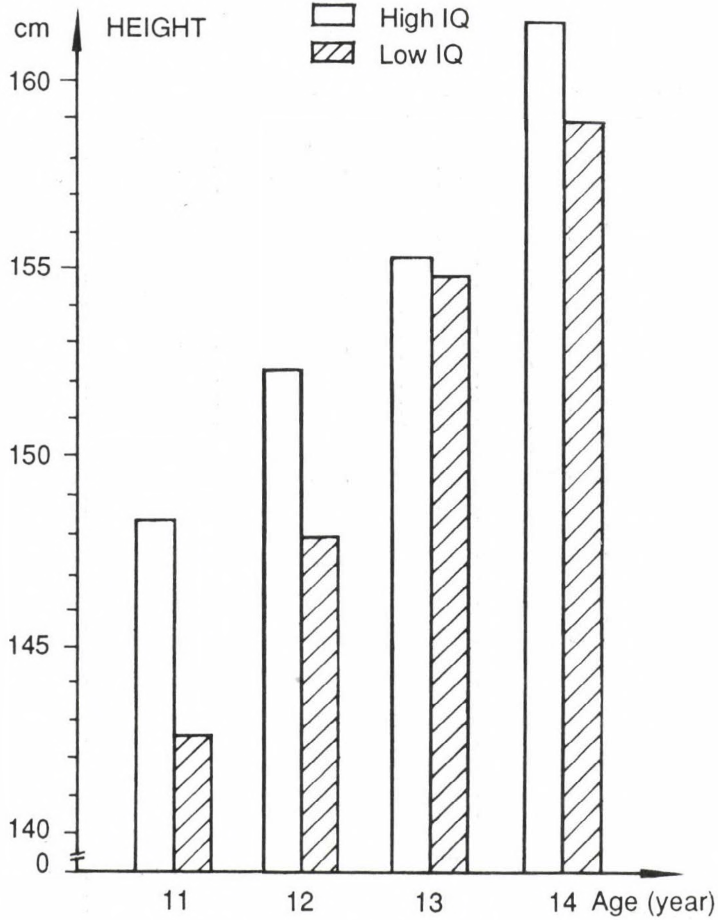

Fig. 4: Height in girls with high and low IQ

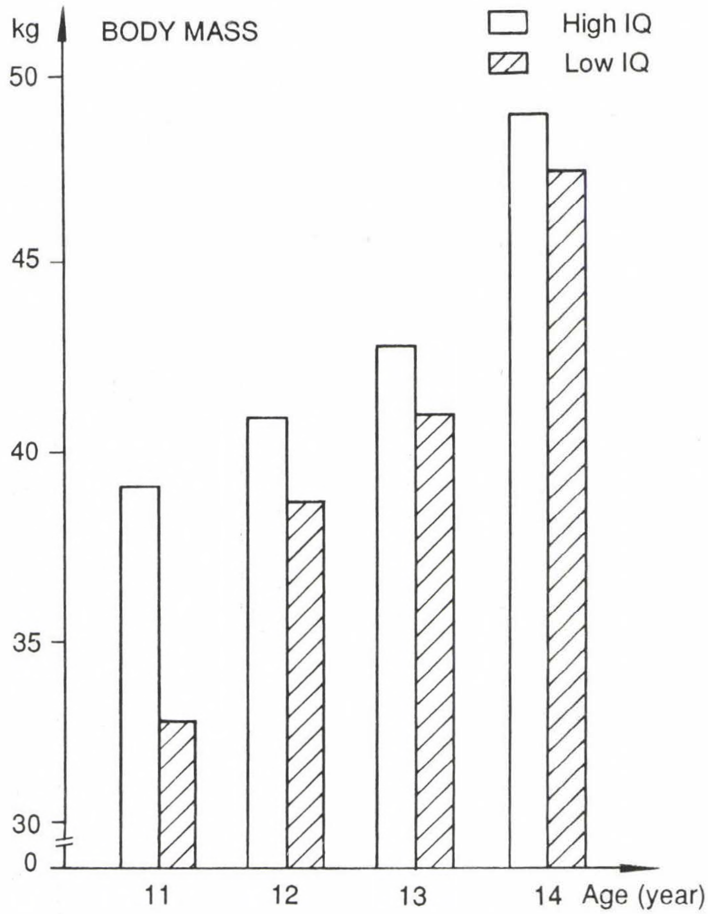

Fig. 5: Body mass in girls with high and low IQ

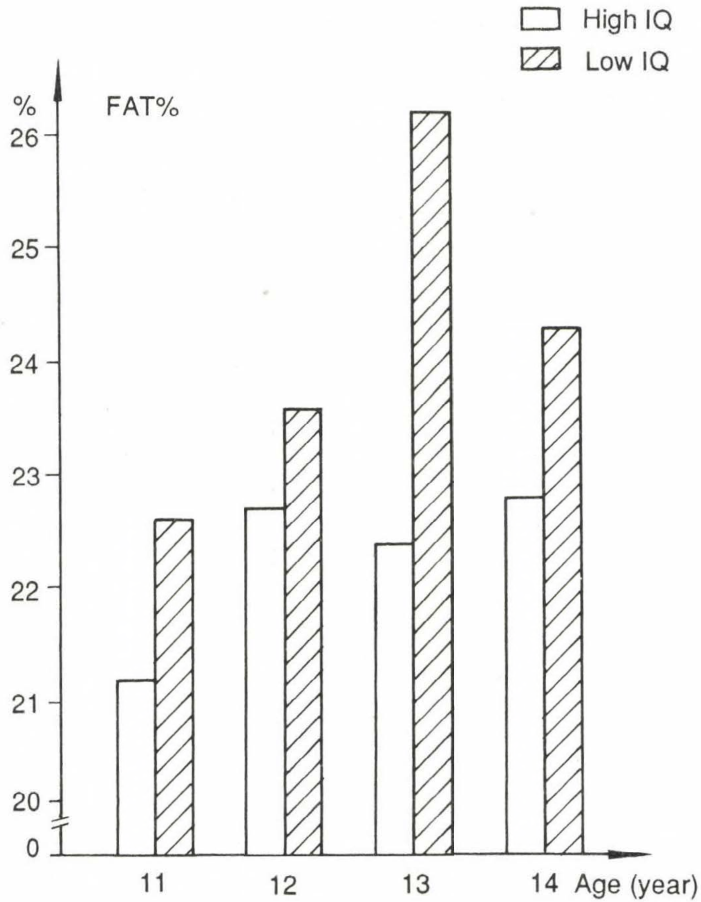

Fig. 6: Percent body fat in girls with high and low IQ

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Anthrop. Közl. *33;* 147–154. (1991)

PRELIMINARY RESULTS OF A STUDY ON CHANGES IN GROWTH OF GIRLS FROM BREMERHAVEN

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Abstract: *The present results are basesd on data collected in two cross-sectional studies on growth and development, the 1. and 2. Bremerhaven Growth Study, which have been carried out in Bremerhaven in 1979/80 (n = 2796) and 1989 (n = 2170). The heights and weights of 10 to 17 year old girls are presented by half year age groups. While for height up to the age of 14.5 years there was only a slight, consistent but statistically not significant, tendency towards an increase over the last 10 years, increase in weight by age was considerable, amounting to 2.5 kg per age group on average. By means of Mann-Whitney-U-test these differences proved to be significant in almost all age groups. These changes in growth are also reflected by an increase of the index of weight for height. They parallel a decrease of mean age at menarche by 0.3 years / decade.*

Key words: *Secular changes; Growth and development; Height; Weight; Menarche; Germany.*

Introduction

For the western parts of Germany there are no recent data on the current state of secular changes in growth and development of children. Data from other European countries as well as from the eastern parts of Germany indicate that although some common features emerge there are some differences between European populations which are worth to be mentioned.

Material and Methods

The present results are based on data which have been collected in two cross-sectional studies with equal design of growth and development of girls from Bremerhaven, the 1. and 2. Bremerhaven Growth Study, carried out in 1979/80 and 1989. Bremerhaven is a city with almost 130 000 inhabitants, located in the northwestern part of Germany. Besides height and weight, which are discussed in the present paper, biacromial and biiliocristal diameters as well as skinfold thicknesses at triceps and subscapular were measured in both studies, furthermore data on menarche were collected. In 1989 sitting height was also measured. Due to the problem to be analyzed with the 1979/80 data, sampling was restricted to girls aged 10 to 16 years. Representative samples of girls of the respective age groups can be obtained in schools from pupils of the 5th to the 10th grades. In Bremerhaven in total there are 13 schools in which these grades are met with. In both studies we asked all girls to participate. Thus from the statistical point of view we are dealing with the population not with a sample and hence there should be no bias due to different sampling frames. In total the present results are based on data from 4966 girls, that is about 70% of the girls of the respective age groups.

The exact decimal age was estimated for each girl from her date of birth and the date of investigation using the table of decimal years (Healy et al. 1981). The age structure of the samples, with the age displayed being the midpoint of the underlying interval, is shown in *Table 1*.

Table 1. **Age structure of the samples**

Age [years]	1979/80 n	1979/80 %	1989 n	1989 %
10.0	16	0.6	9	0.4
10.5	76	2.7	70	3.2
11.0	153	5.5	124	5.7
11.5	195	7.0	185	8.5
12.0	229	8.2	185	8.5
12.5	266	9.5	192	8.9
13.0	243	8.7	177	8.2
13.5	213	7.6	186	8.6
14.0	238	8.5	161	7.4
14.5	251	9.0	169	7.8
15.0	262	9.4	194	8.9
15.5	267	9.5	184	8.5
16.0	215	7.7	161	7.4
16.5	104	3.7	90	4.1
17.0	46	1.6	56	2.6
≥17.25	22	0.8	27	1.2
Total	2796	100.0	2170	100.0

All statistical analyses which comprise estimation of descriptive statistics such as means, standard deviations and centiles as well as statistical tests like the Kolmogorov–Smirnov-test of goodness of fit of the empirical data to the normal distribution model, a parametric *t*-test of significant differences between means and the Mann–Whitney–U-test as nonparametric equivalent (where the assumption of an underlying normal distribution is not met) were performed using SAS software (1990).

Results

The means, standard deviations and centiles of height by age for the two studies are shown in *Figure 1*. Since Kolmogorov–Smirnov-test (for sample sizes less than 51 Shapiro–Wilk's statistic was computed) reveals that except for age groups 11.0 and 16.5 it seems reasonable to asume that we are dealing with a normally distributed trait, mean and standard deviation unequivocally characterize the whole distribution of the trait.

From *Figure 1* it emerges that there is a slight, but consistent tendency of increase in mean *height* from age 11.0 up to 14.5 years over the last decade. The difference ranges between 0.52 cm for girls aged 12.5 years to almost 2 cm in age groups 13.0 and 11.5, respectively. The latter two were the only differences which by means of t-test proved to be significant ($p < 0.01$). To test the significance of the differences t-test or – where there are deviations from the normal distribution model – the nonparametric Mann–Whitney–U-test was performed. The results for girls aged 14.5 years and older indicate that there is no consistent trend in differences of mean heights between the two surveys. The significant negative shift in age goups 10.5 and 17.0 seems to be due to chance, since these age groups include comparatively small numbers of girls which underlines sample size effects on descriptive parameters. The following discussion therefore focusses on results for age groups 11.0 to 16.5. Secular changes in the dis-

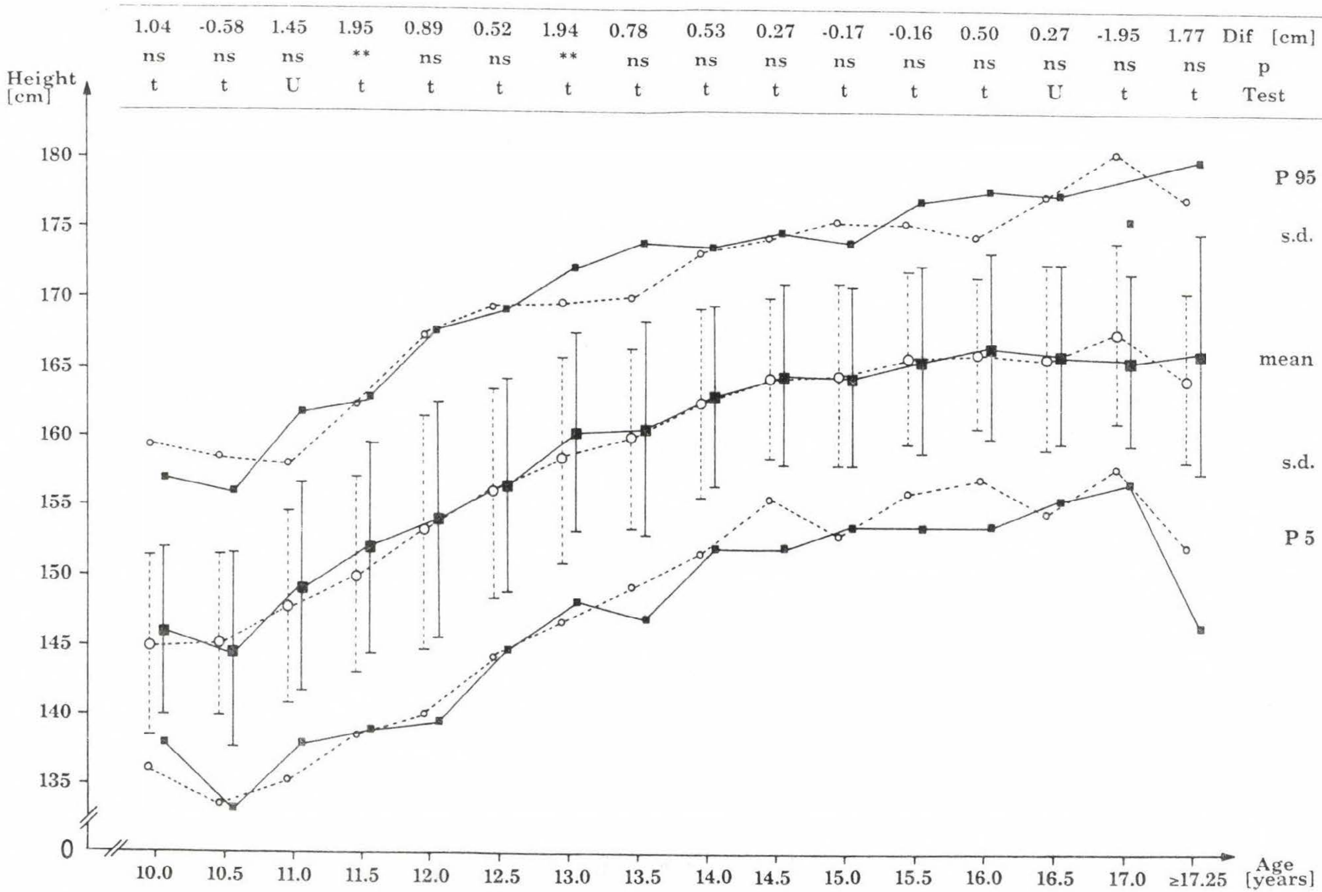

Fig. 1: Mean heights: 1979/80 survey (- - - O - - -) and 1989 survey (——■——)
First row: Differences between means in cm; — second row: Significance level of differences: ns: $p > 0.05$, *: $p \leq 0.05$, **: $p \leq 0.01$, ***: ≤ 0.001; — third row: t indicates that *t*-test and U that Mann–Whitney–U-test was used

tribution of height cannot only affect the location of the distribution, as indicated by different means, but also its shape, which in normally distributed traits is defined by the standard deviation. At a first glance the results show no considerable differences in standard deviations. This is confirmed by the results of the corresponding F-test. Except for age groups 13.5 and 16.0 F-test reveals homogeneity of variances. For these two age groups the t-test statistic for unequal variances was computed. A further approach to analyse secular changes is to look at the centiles. While P_5 shows no regular pattern of variation, the values for P_{95}, except for age group 15.0, more or less show an increase.

Summarizing the results it is noted that in the lower age groups there is a consistent but with two exceptions statistically not significant tendency towards an increase in mean height whereas there are no unequivocal changes in the higher age groups.

The results for *weight* by age are presented by centiles because Kolmogorov–Smirnov-test and Shapiro–Wilk's-test, respectively, revealed that the empirical data of weight do not fit to the normal distribution assumption, at least not in both data sets simultaneously; the only exceptions are age groups 10.5, 13.5 and 16.5. The medians, P_5 and P_{95} of weight by age are shown in *Figure 2*.

The medians of body weight show a marked positiv change over the last decade. The differences between the medians vary from + 0.8 kg to + 4.8 kg. Averaged over the whole age range increase in weight amounts to 2.5 kg per age group. For girls aged 12.0 to 13.5 years increase in mean height is higher as compared to the older girls (except for age group 16.5). In the younger age groups we also find parallel, but not so evident positives changes in body height. Due to the deviations from the normal distribution model the significance of the differences was tested by means of Mann–Whitney–U-test, in all but the three age groups mentioned above. Except for the two lowest and highest age groups – where sample sizes are comparatively small – corresponding tests lead to statistically significant results, in five age groups even at the 0.1% level. The changing pattern in the distribution of weight is also reflected by P_5 and P_{95}. While except for girls aged 12.5 to 13.5 P_5 values show a tendency which – with regard to the magnitude – parallels the differences between the medians, P_{95} values show a considerable increase over the whole age range. The maximum difference amounts to 12.4 kg in 15.0 year old girls.

Summarizing the results for weight there is a marked increase in centiles during the last decade over the whole age range. In the younger age groups increase in weight parallels an increase in height, while from the age of 14.5 years onwards girls gained more weight without being taller. The marked changes in median weight and P_{95} might reflect an increase of the number of overweight girls, which would correspond to Eveleth's and Tanner's observation who in their 1990 edition of "Worldwide Variation of Human Growth" state that in European populations there seems to be a greater difference in weight than reported in the previous edition. Eveleth and Tanner (1990) conclude that there might be a higher prevalence of overweight and obesity in some populations.

So far we dealt with secular changes in size but what about changes in shape? Although there might be different approaches to the problem, we have chosen an age-specific index of weight for height calculated on the basis of individual data [weight (kg) * 10 / height (cm)]. This index relates the two variables linearly.

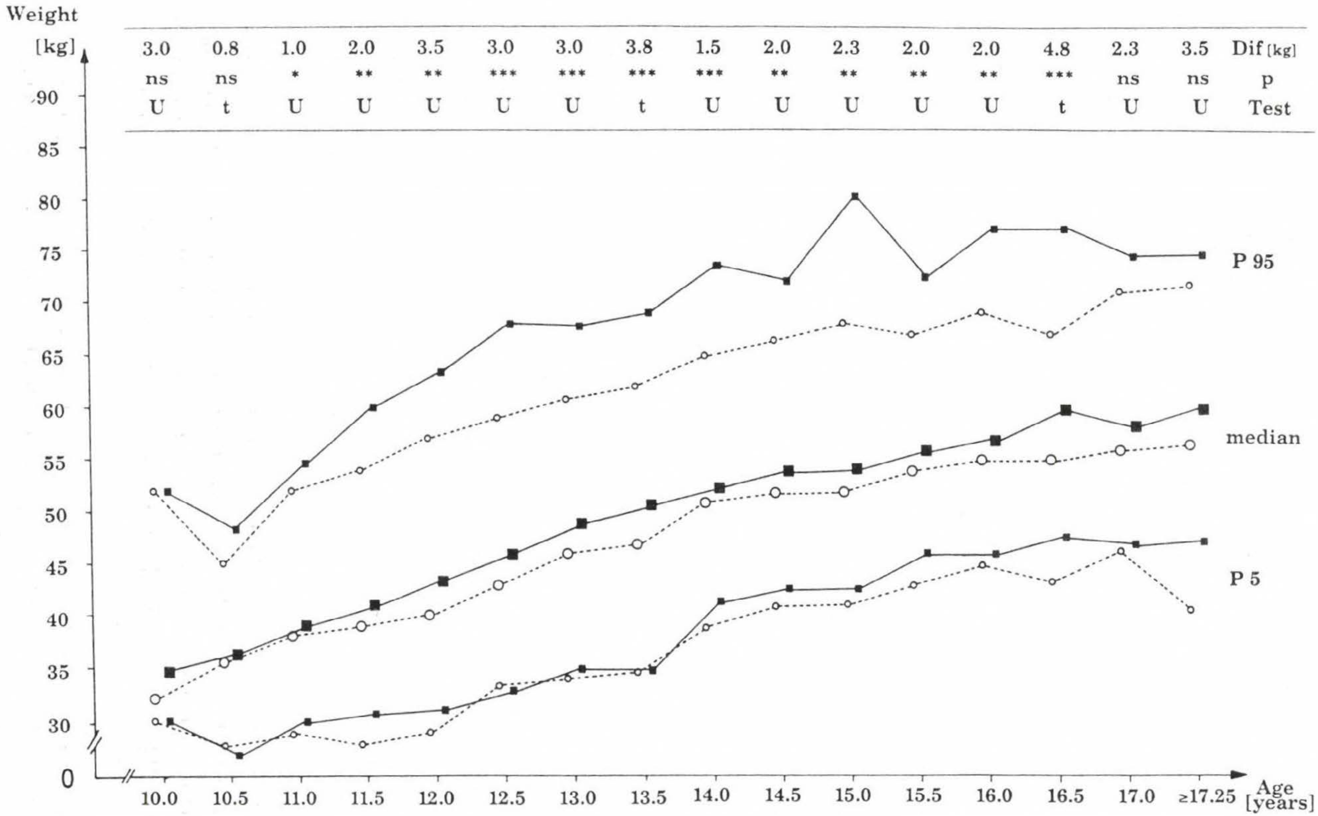

Fig. 2: Centiles of weight: 1979/80 survey (- - - O - - -) and 1989 survey (——■——)
First row: Differences between means in kg; — second row: Significance level of differences: ns: $p > 0.05$, *: $p \leq 0.05$, **: $p \leq 0.01$, ***: ≤ 0.001; — third row: t indicates that *t*-test and U that Mann–Whitney–U-test was used

Since the results of Kolmogorov–Smirnov-test and Shapiro–Wilk-test, respectively, reveal that – as for weight – we are dealing with a trait which seemingly is not normally distributed again centiles are presented instead of means and standard deviations. The centiles of the index of height for weight by age – as shown in *Figure 3* – exhibit the same tendency as those for weight. The differences between the medians are striking and proved to be significant for girls aged between 11.0 and 16.5 years by means of the Mann–Whitney–U-test and *t*-test, respectively; for six age groups even at the 0.1% level. The tendencies of differences in P_5 and P_{95} equal those observed for weight.

These observations thus reflect that the marked changes in weight are not only due to changes in height – not even in the lower age groups – but there is a considerable change in body shape over the last decade. The large differences between the medians of the index of weight for height in the higher age groups underline an increase of weight even in those age groups where mean height obviously did not change over the last decade.

Discussion

Summarizing the results on secular changes in growth and development of an urban sample of girls from northwest Germany it is noted:

1. The differences in height – which have been observed during puberty but not beyond the age of 14.5 – reflect changes in tempo of growth but not in size. Further evidence for tempo effects is provided by data on menarche. Probit analyses revealed mean ages at menarche of 13.30 years for 1979/80 survey and of 13.01 years for the 1989 one. The difference, which amounts to 0.29 years, by means of the *t*-test proved to be highly significant: $t_{(5017)} > 8.25$, $p < 0.001$ (Ostersehlt and Danker-Hopfe 1991). The changing pattern in age at menarche is primarily reflected by increasing proportions of postmenarcheal girls in the lower age groups. So it seems reasonable to assume that the differences in height during puberty – and to a certain extent those in weight – are due to tempo effects.

2. According to Danker-Hopfe and Finke (1991) females in north-west Germany reach adult stature around the age of 16 years. On the basis of combined data for girls aged 15.5 years and older mean heights revealed to be 166.1 cm in the 1979/80 survey and 166.3 cm in the 1989 survey. This leads to our second conclusion that there is no trend in mean height of young adult females.

3. For weight it is quite difficult to distinguish between size and tempo effects since due to nutritional influences weight changes or might change throughout life. This also is reflected in our data where even from age sixteen onwards, where mean height remains fairly unchanged, mean weight by age steadily increases. In contrast to height, secular changes in weight, are not only reflected in a shift of the location of the distribution but also in its shape.

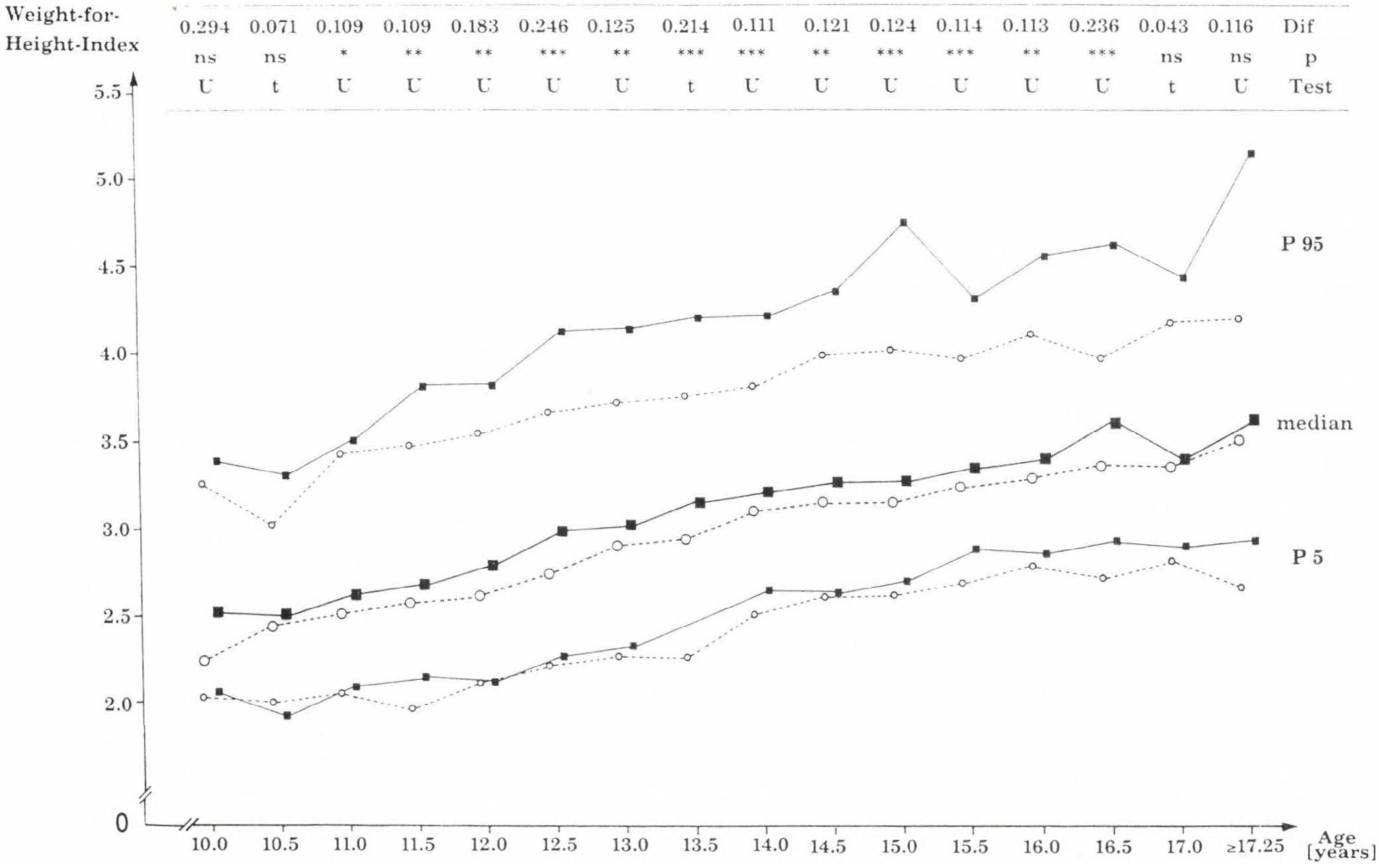

Fig. 3: Centiles of weight-for-height-index: 1979/80 survey (- - - O - - -) and 1989 survey (———■———)
First row: Differences between means; — second row: Significance level of differences: ns: $p > 0.05$, *: $p \leq 0.05$, **: $p \leq 0.01$, ***: ≤ 0.001;
— third row: t indicates that *t*-test and U that Mann–Whitney–U-test was used

4. Changes in body shape – which already emerge from the discussion of the different patterns of changes for height and weight growth separately – are confirmed by the data of weight for height index. In contrast to the thinning down, which often is associated with secular changes in growth and development of children (see e.g. Vercauteren et al. 1984 and Prebeg 1984), Bremerhaven girls show an inverse tendency. There is only one study showing results similar to the present ones. Lindgren and Hauspie (1989) reported a slight positive secular change in mean height for Swedish schoolgirls aged between 10 and 15 years while there is a marked increase in body weight over the whole age range.

It would be interesting to analyse to what extent the present results reflect an increasing prevalence of overweight. This aspect will be analyzed in the near future taking into account different definitions of overweight.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 29 July, 1991.

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Anthrop. Közl. *33;* 155–163. (1991)

SECULAR TREND OF MORPHOFUNCTIONAL STATUS OF LITHUANIAN CHILDREN

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Abstract: *The study was carried out in Vilnius secondary schools and kindergartens in 1985. The sample consisted of 3792 children from 2 to 18 years of age. The data of morphofunctional status of modern children were compared with the data of 1965 study. It was determined positive trend of stature (due to lengthening of legs with maximal values at the middle of adolescence). Body mass and chest circumference increased proportionally to height only in boys, while in girls relative decreasing of these indices was found. Gracilization and leptosomization of the upper part of the body (decreasing of head and chest widhts) was evident, while bicristal diameter increased proportionally to stature acceleration. The all functional characteristics had negative tendency since 1965 (blood pressure increased, vital capacity and grip of both hands diminished at all age and in both sexes). The most striking factors of negative changes were worsened socio-economical and ecological situation in Lithuania during last two decades, also decreasing of physical activity and wrong nutrition.*

Key words: *Secular trends; Morphofunctional status; Vilnius Growth Study.*

Introduction

The examination of the variability of man in time and space, the determination of the main directions of secular trends of modern youth still is one of the main problem of anthropology as well as genetics, paediatrics and ecology. Biological changes reflect the stresses of all kinds of life as a mirror: socio-economic situation, natural environment, industrial and urbanization transformations. Therefore studies of secular trends now represent an important part of research in human biology, but the whole question still is unsolved (see Wolanski 1988).

The course and the main directions of secular trends in various countries are different. Secular trends can be positive, negative or absent, also secular changes are not universal and are reversible (Malina 1990). The main part of the investigators confirms the positive secular trends of growth and development (Hajnis et al. 1983, Roede – Wieringen 1985, Eiben 1989, Jaeger et al. 1990), but at the same time the positive changes of one indices and the negative of the other ones (Farkas 1983, Vercauteren et al. 1984, Rode – Shephard 1984, Tomazo-Ravnik 1988, Hulanicka et al. 1990, Lausvee 1991), disproportional development (Ostersehlt – Danker-Hopfe 1991) are evident. There are also the references on the diminishing or stopping of the rate and tempo of acceleration of the main morphofunctional indices (Chinn – Rona 1984, Shohoji – Sasaki 1984, Eiben 1988, Miklashevskaya – Godina 1988, Lindgren 1988, Lindgren 1991). In some countries the trend at least slowed down (see Malina 1990).

As with the data on growth and development of Lithuanian children, the positive secular trends of all morphofunctional indices were observed until the 1965s (Pavilonis et al. 1974). It was interesting to determine the peculiarities of secular changes of morphofunctional status of Lithuanian children after 1965s until 1985s.

Subjects and Methods

The present resuts are based on a growth study carried out in Vilnius (the capital of Lithuania) secondary schools and kindergartens in 1985. The sample totalled 3792 children from 2 to 18 years of age. More then 100 children of each age and sex group were examined. The children aged from 2 to 6 years were examined according to the short programme (see *Table 1*). The morphological as well as functional indices also sexual maturation were recorded to each children aged from 7 to 18 years (see *Table 2*). Standard anthropometric and physiometric methods were used (Martin – Saller 1957). Sexual maturation was evaluated by Tanner (1973) and by Pavilonis methods (Pavilonis et al. 1974). Data were computed using standard programs of packet BMDP 4M. Present results were compared with the data of morphofunctional status of Vilnius children in 1965s (Pavilonis et al. 1974) for the purpose to reveal various changes. The statistical significance of the differences was determined using Student *t*-test.

Table 1. **Morphological measurements of Lithuanian (Vilnius) children of 2–6 years**

Age (year)	N	Height (cm)		Weight (kg)		Chest circumference (cm)	
		x	SD	x	SD	x	SD
Boys							
2	106	89.17	4.56	13.13	1.57	51.24	2.17
3	120	95.19	5.26	14.67	1.83	52.00	1.99
4	105	104.33	5.03	16.72	2.08	54.51	2.19
5	113	110.05	5.13	18.65	2.60	56.23	2.66
6	125	118.12	5.58	21.85	4.42	59.07	3.98
Girls							
2	100	87.60	4.54	12.34	1.62	49.76	2.18
3	110	95.27	4.79	14.30	2.16	51.51	2.58
4	121	103.20	5.02	16.44	2.76	53.47	2.67
5	117	111.02	5.20	18.91	2.79	55.38	2.69
6	118	116.66	5.47	20.56	3.82	56.85	3.42

Results and Discussion

Summarising data of selected morphological and functional indices at various age periods (*Table 1* and *2*) and comparing them with the data from the other countries we can make a conclusion that modern Lithuanian children are one of the tallest in the world. Lithuanians have similar relative weight and slightly less transverse diameters of the upper part of the body (according to height), functional characteristics don't differ notably from the data of the other countries, but the blood pressure is considerably higher.

Analyzing our two comparable samples, it was found the absence of secular trend in younger children aged from 2 to 6 years. It correspponds the data of Polish population very well (Hulanicka et al. 1990). We are in the same opinion as the Polish investigators: this absence of secular trend is due to worsened economic and ecological situation during last two decades in Lithuanian also as in Poland. For example in Netherlands (Roede – Wieringen 1985) positive secular trend of growth indices at this period of life was evident.

Table 2. **Means of selected morphological and functional measurements of Lithuanian (Vilnius) children of 7–18 years**

Body measurements	Age groups (year)					
	8	10	12	14	16	18
Boys						
Stature, cm	131.4	140.7	150.7	164.8	176.2	179.6
Head height, cm	21.0	21.2	21.3	22.1	22.8	22.9
Face height, cm	10.5	10.8	11.1	11.5	12.1	12.3
Trunk length, cm	38.6	40.7	43.9	48.8	53.9	54.8
Leg length, cm	69.4	76.1	83.1	90.9	95.7	96.2
Weight, kg	28.3	33.5	41.4	51.1	65.3	70.7
Head circumference, cm	52.7	54.1	54.8	55.4	57.0	57.0
Chest circumference, cm	62.6	67.3	72.8	77.4	89.6	92.0
Abdomen circumference, cm	56.3	60.0	64.3	68.1	74.1	76.8
Hip circumference, cm	66.0	71.6	77.4	83.6	92.1	95.0
Shoulder width, cm	28.9	29.9	31.4	35.2	38.2	40.0
Chest width, cm	19.4	20.3	22.1	23.8	25.4	27.7
Chest depth, cm	12.9	14.1	15.5	16.5	18.2	19.4
Hip width, cm	20.4	21.3	23.2	25.1	27.3	27.8
Vital capacity, ml	1437	1887	2303	2978	4110	4338
Right hand grip, KG	13.0	18.3	25.6	32.8	45.8	46.5
Left hand grip, KG	12.0	16.4	23.6	30.8	42.6	43.1
Systolic B.P., mmHG	104.2	110.2	109.6	117.4	126.1	127.6
Diastolic B.P., mmHG	59.9	70.2	71.1	73.7	78.6	79.8
Girls						
Stature, cm	130.4	139.9	150.0	161.9	165.5	165.6
Head height, cm	20.1	20.5	20.5	21.3	21.3	21.3
Face height, cm	10.3	10.4	11.0	11.1	11.3	11.3
Trunk length, cm	37.8	39.9	42.6	47.7	51.0	51.0
Leg length, cm	69.6	76.3	83.0	88.8	88.9	89.2
Weight, kg	27.0	32.5	39.4	52.2	59.0	60.0
Head circumference, cm	52.0	53.3	54.0	55.3	56.0	56.0
Chest circumference, cm	60.4	64.0	70.2	80.1	84.3	84.3
Abdomen circumference, cm	53.8	57.0	60.0	66.0	69.0	69.2
Hip circumference, cm	65.7	71.2	77.5	89.9	95.0	96.2
Shoulder width, cm	28.2	29.7	31.4	34.5	35.5	35.7
Chest width, cm	18.7	19.7	21.2	23.3	23.7	24.3
Chest depth, cm	12.3	13.5	14.8	16.4	16.9	17.4
Hip width, cm	20.1	21.5	23.3	26.3	27.5	27.9
Vital capacity, ml	1315	1687	2155	2695	2952	3096
Right hand grip, KG	10.0	15.9	21.3	27.5	29.2	27.6
Left hand grip, KG	9.5	14.2	18.9	24.8	26.9	24.0
Systolic B.P., mmHG	101.8	106.8	110.5	120.3	125.4	126.8
Diastolic B.P., mmHG	58.6	65.4	70.1	75.5	80.0	81.6

All these changes of growth and development occur with the beginning of the adolescence. Therefore the sample of children from 7 to 18 years of age was examined carefully according to the large programme. Let us discuss our results:

(1) Positive secular trend in height was observed in all age and sex groups (*Table 3*). The maximal values of height acceleration were found in the middle of adolescence. Secular trend of stature is more expressed in boys then in girls. This fact confirms the opinion about more sensitive male organism compare to female one (Stinson 1985, Wolański 1988). As with the other longitudinal measurements, only the positive changes of face and leg length was observed, while the trunk length didn't change between 1965 and 1985s. Consequently, the increment of the height in both sexes during last two decades is due to lengthening of the legs. It coincides with the data of the other authors (Gonzales et al. 1982, Dahlström 1984).

(2) Absolute amount of body mass increased in both sexes, but this increment was proportional to the height acceleration only in boys, while in girls relative decreasing of this index was found (*Table 3*). The very similar data of cities also were confirmed by Polish (Hulanicka et al. 1990) and the other authors (Tomazo-Ravnik 1988). On the other hand, positive and considerable secular changes of body mass in boys as well as in girls were found by several investigators also (Ostersehlt – Danker-Hopfe 1991, Silla – Teoste 1991). We would like to relate changes of weight in Lithuanian girls more with the changes in life stile and modern canons (fashion) of optimal body mass then with the other factors.

(3) Secular trend of head circumference is absent and it shows a big stability of the head in time. Chest circumference in boys increased only at the end of the adolescence (*Table 3*). No evident changes of this index were observed in girls. That is why modern girls have relative less chest circumference (compare to the increment of height). The same results have been reported by Farkas (1983), by Eiben (1988) and by Lausvee (1991). Summarizing the changes in the other circumferences of the body of Lithuanian children, it should be pointed out proportional increment of abdomen circumference in boys, but in girls the same process is evident only at the end of adolescence. It is necessary to stress that the hip circumference in boys did not change significantly while this index in modern girls is relatively less. We can call such process in girls as becoming the shape of the body more "cylindrical". One can found the similar data in auxological literature also (Vercauteren et al. 1984).

(4) Analyzing the changes of transverse diameters of the body the significant and big diminishing of the indices of the upper part was determined (*Table 4*). For example the width of head and face, also both diameters of the chest in modern youth is remarkable less while hip (bicristal) width increased significantly in all age and sex groups. How to explain two different trends in girls – the relative decreasing of hip circumference and increment of hip width? It can be related to diminishing of subcutaneous soft tissues (fat, muscles), because relative less body mass in modern girls was found also. We have although data on body composition of contemporary youth; unfortunately these data from 1965s are not available and comparison is impossible. As to shoulder (biacromial) width no evident changes were found. Consequently the gracilization and leptosomization of the upper part of the body took place between 1965 and 1985s. There are also the data in the auxological literature on the same process of the lower part of the body (Tomazo-Ravnik 1988).

Table 3. **Estimated differences in the main morphological indices of Lithuanian (Vilnius) children in 1965 and 1985 studies**

Age (year)	Height	Face height	Leg length	Weight	Chest circumference	Abdomen circumference	Hip circumference
Boys							
7	1.6**	0.8***	0.6	–0.8	0.0	0.3	–0.6
8	2.6***	0.7***	1.7***	0.1	–0.4	0.2	–1.0
9	3.6***	0.5***	1.1*	1.1	–1.0	1.0	–1.1
10	2.3***	0.6***	1.7***	0.5	–0.9	0.5	–0.9
11	4.2***	0.7***	2.1***	1.7	0.0	1.5*	0.3
12	4.3**	0.6***	1.3***	2.4*	0.2	1.9*	0.6
13	4.2***	0.6***	1.8***	2.5*	0.5	3.0***	1.3
14	5.2***	0.5***	1.7***	2.2*	0.9	2.4***	0.8
15	5.0***	0.4***	1.3***	3.5**	1.1	2.9***	2.3*
16	5.1***	0.4***	1.2**	3.7***	3.0***	3.0***	0.3
17	4.4***	0.6***	1.2***	1.7	1.8*	2.4***	0.3
18	4.0***	0.5***	1.2**	1.7	2.0*	2.3**	1.3
Girls							
7	0.2	0.5***	1.1*	–1.1	–0.5	–1.9***	–2.9***
8	2.8***	0.8***	1.2**	–0.3	–1.9***	–1.0*	–3.4***
9	2.2***	0.7***	1.3***	0.3	–0.8	–0.4	–2.2**
10	2.7***	0.6***	2.0***	–0.3	–2.4***	–1.7*	–2.5***
11	4.1***	0.9***	2.9***	2.1*	–0.7	–0.7	–1.7
12	2.0*	0.7***	1.2**	0.7	–1.6	–1.4	–1.8
13	4.9***	0.7***	3.0***	1.3	0.7	0.2	–0.3
14	3.0***	0.5***	2.2***	1.3	0.5	–0.8	–0.2
15	2.8***	0.3***	1.1*	0.9	1.5*	0.2	–0.7
16	2.9***	0.4***	1.1*	1.6	1.0	1.2	–0.1
17	3.2***	0.5***	1.1**	2.1**	2.3***	2.1**	0.3
18	2.2***	0.5***	1.2**	1.4	–0.3	2.1**	0.5

— $p > 0.05$
* — $p > 0.05$
** — $p < 0.01$
*** — $p < 0.001$

Table 4. **Estimated differences in the transverse measurements of Lithuanian (Vilnius) children in 1965 and 1985 studies**

Age (year)	Head width	Face width	Chest width	Chest depth	Shoulder width	Hip width
Boys						
7	-0.8^{***}	-1.9^{***}	-0.6^{***}	-1.9^{***}	1.3^{***}	1.2^{***}
8	-0.9^{***}	-1.6^{***}	-0.6^{**}	-1.8^{***}	1.3^{***}	1.7^{***}
9	-0.6^{***}	-1.5^{***}	-0.4^{*}	-2.0^{***}	1.1^{***}	1.9^{***}
10	-0.9^{***}	-1.2^{***}	-0.8^{***}	-1.5^{***}	0.6^{**}	1.8^{***}
11	-0.7^{***}	-1.0^{***}	-0.5^{**}	-1.5^{***}	0.9^{**}	1.8^{***}
12	-0.7^{***}	-0.8^{***}	-0.4^{*}	-0.8^{***}	-0.4	1.7^{***}
13	-0.5^{***}	-0.8^{***}	-0.5^{*}	-0.9^{***}	-0.0	2.3^{***}
14	-0.4^{***}	-1.0^{***}	-0.6^{**}	-1.0^{***}	1.0^{**}	2.1^{***}
15	-0.6^{***}	-1.1^{***}	-1.0^{***}	-1.1^{***}	1.3^{***}	2.6^{***}
16	-0.7^{***}	-1.4^{***}	-1.5^{***}	-0.9^{***}	1.4^{***}	2.7^{***}
17	-0.7^{***}	-0.9^{***}	-0.9^{***}	-0.9^{***}	1.8^{***}	2.2^{***}
18	-0.6^{***}	-0.8^{***}	-0.9^{***}	-0.9^{***}	1.0^{**}	2.4^{***}
Girls						
7	-1.0^{***}	-1.4^{***}	-0.8^{***}	-1.0^{***}	0.4	1.1^{***}
8	-0.8^{***}	-1.5^{***}	-0.3	-1.7^{***}	0.3	1.3^{***}
9	-0.5^{***}	-1.2^{***}	-0.2	-1.6^{***}	0.3	1.3^{***}
10	-0.8^{***}	-0.9^{***}	-0.7^{***}	-1.0^{***}	0.7^{***}	1.7^{***}
11	-0.6^{***}	-0.7^{***}	-0.5^{*}	-0.9^{***}	0.8^{***}	2.0^{***}
12	-0.5^{***}	-0.8^{***}	-0.4^{*}	-1.2^{***}	-0.4	1.3^{***}
13	-0.4^{***}	-0.8^{***}	-0.5^{*}	-0.7^{***}	0.3	1.4^{***}
14	-0.4^{***}	-0.8^{***}	-0.5^{*}	-0.8^{***}	0.3	1.5^{***}
15	-0.5^{***}	-1.2^{***}	-0.9^{***}	-0.7^{***}	0.1	1.0^{***}
16	-0.5^{***}	-1.1^{***}	-0.9^{***}	-0.4^{*}	0.0	1.1^{***}
17	-0.6^{***}	-0.7^{***}	-1.0^{***}	-0.5^{*}	0.3	1.7^{***}
18	-0.6^{***}	-0.8^{***}	-0.8^{***}	-0.5^{*}	0.1	1.8^{***}

— $p > 0.05$
* — $p > 0.05$
** — $p < 0.01$
*** — $p < 0.001$

Table 5. **Estimated differences in the functional characteristics of Lithuanian (Vilnius) children in 1965 and 1985 studies**

Age (year)	Systolic blood pressure	Diastolic blood pressure	Vital capacity	Right hand grip	Left hand grip
Boys					
7	0.8	3.2***	–99***	–2.0***	–2.2***
8	6.8***	6.3***	–246***	–3.1***	–2.7***
9	7.7***	7.7***	–212***	–4.3***	–4.1***
10	8.5***	12.8***	–156***	–8.4***	–6.3***
11	7.4***	10.6***	–100	–5.3***	–5.2***
12	4.2***	13.3***	–131*	–4.8***	–4.5***
13	5.5***	11.6***	29	–5.5***	–4.1***
14	9.3***	11.3***	–273***	–8.4***	–6.8***
15	9.4***	7.4***	–294***	–8.7***	–7.3***
16	8.3***	7.3***	–187*	–7.8***	–7.0***
17	12.2***	8.0***	–287**	–10.0***	–8.2***
18	3.6*	5.8***	–558***	–15.5***	–12.8***
Girls					
7	5.4***	4.1***	–242***	–1.7***	–1.3***
8	5.1***	1.6	–314***	–3.3***	–2.2***
9	4.9***	3.3***	–292***	–3.2***	–3.0***
10	6.8***	5.8***	–367***	–5.3***	–5.7***
11	7.9***	6.1***	–128*	–4.7***	–5.1***
12	5.1***	8.9***	–54	–5.0***	–5.2***
13	7.2***	11.2***	–46	–4.5***	–4.1***
14	11.0***	7.1***	–176**	–7.1***	–6.8***
15	9.1***	7.9***	–254***	–7.5***	–5.9***
16	12.1***	9.2***	–326*	–9.5***	–8.1***
17	12.1***	7.8***	–225**	–8.5***	–9.1***
18	12.7***	9.7***	–136**	–12.3***	–12.5***

— $p > 0.05$
* — $p > 0.05$
** — $p < 0.01$
*** — $p < 0.001$

(5) All the functional characteristics have significant negative changes (*Table 5*). The sever increasing of blood pressure, striking diminishing of vital capacity (it was the cause of deceleration of chest diameters) and hand grip took place in growth and development of modern youth. It must be stressed that all these indices diminished while stature increased at the same time. It means that we have some degree of asthenization of the body the causes of which took place in the environment during last two decades in Lithuania.

Let us try to explain such situation. As it concerns diminishing of strength and vital capacity we can pointed out the decreasing of physical activity, "sitting" life style. Such a big increment of blood pressure we can not explain only with the acceleration of height. More vulnerable factors such as increasing of urbanization, social and other stresses, changes in life style (fast tempo and rate), also the worsening of the ecological situation during last decades can play the important role.

(6) Sexual maturataion of boys have no evident changes during the period between 1965 and 1985s: the mean age of oigarche in 1985s was M = 14.72 ± 0.09 year (SD = 0.93) and was on 0.6 month younger (P > 0.05) then that in 1965s. As with maturation of girls it may be concluded that nowadays the average maturation process takes place in a shorter time, because the intervals between the beginning and the finishing of various second sexual characteristics are shorter and the whole process of maturation is more sharp and quick. The same results have been reported also by Roede – Wierengen (1985). The most striking fact is that in the middle of adolescence sever deviations occurred since SD became relative very high. The acceleration of menarche was observed only until 1980s (it was 13.07) while later it retarded: in 1985s menarche was M = 13.37 ± 0.11 year (SD = 1.08). In some countries this trend also seems to have stopped or even retarded, e.g. Poland (Laska-Mierzejewska et al. 1989, Hulanicka et al. 1990), Hungary (Eiben 1982, Farkas 1983), United Kingdom (Roberts 1985), USSR (Miklashevskaya – Godina 1988), Sweden (Lindgren 1991) and in other (see Danker-Hopfe 1986). It can be related with different causes. One might suppose that retardation of menarche suggests that biological maximum was reached (Lindgren 1988, Malina 1990). As it concerns Lithuania we are of the same opinion as the Polish investigators – the worsened economic and ecological situation in Lithuania took place during last time.

Summarizing results of present study we can stres that until 1965s in Lithuania high acceleration of all morphological as well as functional indices was observed while later sever negative trends took place. As the stature is the most stabile morphological index negative factors did not influence the height so sever like such sensitive indices as functional measurements and sexual maturation. Is it normal or abnormal – this is the difficult question. Maybe it is only the phase or moment of the whole process of long-term biological changes of man in time and space which exhibit fluctuations (Wangermez 1984, Wolanski 1988). Some authors associate it with changees in solar activity (Nikityuk and Alpatov 1984). Consequently, such morphofunctional status is the norm of modern youth. If it leads to diminishing of power, strength and activity of growing organism – such changes are negative and very striking. Not only anthropologists and pediatricians, but also the whole society must take it into account.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 29 July, 1991.

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Anthrop. Közl. 33; 165–170. (1991)

CHANGES IN THE BIRTH WEIGHT, BIRTH LENGTH, AND HEAD CIRCUMFERENCE OF HUNGARIAN CHILDREN IN COUNTY BARANYA BETWEEN 1968 AND 1979–81

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Abstract: *Possible secular changes of newborn's body measurements were investigated in a cross-sectional growth study in County Baranya (South Hungary) in 1979–81 years on a sample of 2130 infants. The findings were compared with those of Fekete et al. (1968, 1974) obtained in the same region on 3567 neonates. During the 12-years interval the birth weight of children slightly increased, the head circumference did not change in girls but slightly decreased in boys. The birth length values could not be evaluated because of the technical reason. According to the results secular changes in the newborn body measurements could not have been realised during the period investigated. The fetal growth standard of Fekete et al. (1968, 1974) is still suitable and a repeated anthropometric investigation of newborns is necessary in the near future.*

Key words: *Birth weight; Biorth length; Head circumference; Baranya county / Hungary.*

Introduction

The phenomenon known as secular trend concerns physical maturation of children occuring more rapidly and children becoming larger at all ages, even at birth (Tanner 1966, Van Wieringen 1978, Susanne 1984, Eiben 1988). It is clear that among causes of secular changes in growth and maturation the changes in socioeconomic and demographic factors are of special importance.

Between the 1960s and early 1980s markerd demographic and socioeconomical changes occured in Hungary, consequently in County Baranya, some selected indeces of which are shown in the *Table 1*.

Table 1. **Some sociodemographic data of Baranya County changed during the period investigated**

Sociodemographic data	1968	1980
The number of inhabitants	177 000	434 340
Birth rate (°/oo)	15.3	13.7
Natural increase	2.5	0.3
Infant mortality, 0—365 days	42.8	20.6
The ratio of workers of the hand and brain	3.2	2.4
Number of physicians per 10 000 inhabitants	28	36

Since intrauterin growth charts were constructed in 1968 in our county with performed body measurements in 1979–81 in order to see whether significant changes had occured and a secular trend could be demonstrated.

Material and Methods

Body measurements were performed in 2130 newborn infants, 1073 boys and 1057 girls (*Table 2*) in the neonatal unit of the Baranya County Hospital between February 1, 1979 – March 31, 1980 and January 1, 1981 – May 31, 1981. The data covered all "healthy" liveborn singletons of estimated gestational age of 30–41 weeks. Infants with major congenital abnormalities, erythroblastosis or marked fetal malnutrition, infants born to diabetic mothers were not included.

Table 2. **The number of patients by age and sex in the Baranya–I and Baranya–II**

Gestational age (weeks)	Baranya–I (Fekete et al. 1974)			Baranya–II (present study)		
	Boys	Girls	Total	Boys	Girls	Total
30	31	37	68	5	9	14
31	33	30	63	10	3	13
32	43	34	77	6	8	14
33	37	32	69	12	7	19
34	49	47	96	19	25	44
35	49	59	108	29	22	51
36	110	88	198	45	63	108
37	104	72	176	95	83	178
38	203	160	363	183	184	367
39	328	299	627	301	297	598
40	411	391	802	257	246	503
41	262	229	491	111	110	221
Sum total	1886	1681	3567	1073	1057	2130

The gestational age of babies was calculated from the first day of the last normal menstrual period. In every case clinical assessment of gestational age was performed by the Dubowitz scoring system (1970). Whenever a definite date of the last normal period was not stated or the calculated gestational age was not compatible with the obtained by clinical assessment, the infant was not included.

All the measurements were made in duplicate in the first 36 hours of age, by the same person using an infant scale (made by Metripond, type N° 292), an infant length measuring board and a flexible narrow steel tape. The measurements include birth weight, length (the crown-heel length) and the head circumference.

Birth length measurements were made with the infant flat on his back, head touching the crib end, both knees straight and pressed to the matress, and feet at left angles. Head measurements were made with light pressure using a flexible narrow steel tape arround the largest occipitofrontal circumference.

In the course of mathematical-statistical evaluation, the usual parameters were calculated (x = means, SD = standard deviation), by which the results of the two investigations (Baranya–I of Fekete et al. 1968, 1974 and the present study Baranya–II) were comparable. The statistical differences were computed by Student *t*-test.

The results are shown in the *Tables 3–8.*

Results

In Baranya–II the mean *birth weight* values of newborn babies, 170–190 grams in boys at 35–37 and 39 gestational weeks, 90–190 grams in girls at 36–39 weeks were haevier than in Baranya–I. The difference at other gestational weeks was not significant (*Tables 3–4*).

Table 3. **Birth weight (g) in boys**

Gestational age (weeks)	Baranya–I (Fekete et al. 1968, 1974)		Baranya–II (present study)		
	x	SD	x	SD	P
30	1580	350	1750	215	NS
31	1740	370	1810	265	NS
32	1920	420	1990	390	NS
33	2130	440	2260	380	NS
34	2350	450	2530	340	NS
35	2560	450	2750	325	+
36	2800	470	2990	360	++
37	3040	480	3210	370	++
38	3220	460	3340	380	NS
39	3340	460	3430	395	++
40	3420	460	3480	405	NS
41	3480	460	3520	450	NS

+ + + $p < 0.001$; + + $p < 0.01$; + $p < 0.05$ NS; Baranya–II > Baranya–I
– – – $p < 0.001$; – – $p < 0.01$; – $p < 0.05$ NS; Baranya–I > Baranya–II

Table 4. **Birth weight (g) in girls**

Gestational age (weeks)	Baranya–I (Fekete et al. 1968, 1974)		Baranya–II (present study)		
	x	SD	x	SD	P
30	1540	390	1710	255	NS
31	1700	410	1770	305	NS
32	1850	380	1920	350	NS
33	2050	400	2180	340	NS
34	2270	450	2450	340	NS
35	2480	480	2670	355	NS
36	2660	480	2850	370	++
37	2820	440	2990	330	++
38	2970	440	3090	360	++
39	3100	430	3190	365	++
40	3210	420	3270	465	NS
41	3280	420	3320	410	NS

+ + + $p < 0.001$; + + $p < 0.01$; + $p < 0.05$ NS; Baranya–II > Baranya–I
– – – $p < 0.001$; – – $p < 0.01$; – $p < 0.05$ NS; Baranya–I > Baranya–II

In Baranya–II the mean *birth–length* of newborns was smaller by 1.6–3.9 cm in boys and by 1.5–4.6 cm in girls at 34–41 gestational weeks than in Baranya–I (*Tables 5–6*).

Table 5. **Birth length (cm) in boys**

Gestational age (weeks)	Baranya–I (Fekete et al. 1968, 1974)		Baranya–II (present study)		
	x	SD	x	SD	P
30	42.1	3.60	42.6	2.42	NS
31	43.4	3.30	42.8	2.01	NS
32	44.7	3.20	43.5	1.83	NS
33	46.2	3.50	44.9	1.80	NS
34	47.6	3.40	46.0	1.71	– – –
35	49.0	3.20	47.0	1.42	– – –
36	50.4	3.00	47.7	1.60	– – –
37	51.7	2.90	48.3	1.64	– – –
38	52.7	2.80	48.9	1.71	– – –
39	53.5	2.80	49.6	1.63	– – –
40	54.1	2.90	50.2	1.60	– – –
41	54.6	3.00	50.9	1.84	– – –

+ + + $p < 0.001$; + + $p < 0.01$; + $p < 0.05$ NS; Baranya–II > Baranya–I
– – – $p < 0.001$; – – $p < 0.01$; – $p < 0.05$ NS; Baranya–I > Baranya–II

Table 6. **Birth length (cm) in girls**

Gestational age (weeks)	Baranya–I (Fekete et al. 1968, 1974)		Baranya–II (present study)		
	x	SD	x	SD	P
30	42.4	3.60	42.9	2.42	NS
31	43.6	3.50	43.0	2.21	NS
32	44.8	3.50	43.6	2.03	NS
33	46.0	3.50	44.7	1.80	NS
34	47.2	3.40	45.6	1.71	–
35	48.5	3.40	46.5	1.62	– – –
36	49.7	3.20	47.0	1.80	– – –
37	50.9	3.10	47.6	1.84	– – –
38	51.9	3.00	48.4	1.91	– – –
39	52.6	3.00	48.9	1.83	– – –
40	53.1	3.10	49.5	1.80	– – –
41	53.2	3.00	50.1	1.84	– – –

+ + + $p < 0.001$; + + $p < 0.01$; + $p < 0.05$ NS; Baranya–II > Baranya–I
– – – $p < 0.001$; – – $p < 0.01$; – $p < 0.05$ NS; Baranya–I > Baranya–II

In Baranya–II the mean head circumference of newborn babies were very similar to those of Baranya–I, except at the gestational ages of 39–40 in girls, where the Baranya–II mean head circumference values were bigger, than those of Baranya–II (*Tal .es 7–8*).

Table 7. **Head circumference (cm) in newborn boys**

Gestational age (weeks)	Baranya–I (Fekete et al. 1968, 1974)		Baranya–II (present study)		
	x	SD	x	SD	P
30	28.7	2.04	29.6	1.85	NS
31	29.6	2.10	29.7	1.87	NS
32	30.3	1.90	30.3	1.53	NS
33	31.0	1.70	31.1	1.47	NS
34	31.7	1.80	31.8	1.37	NS
35	32.4	1.80	32.5	1.22	NS
36	33.1	1.70	33.1	0.73	NS
37	33.7	1.41	33.6	1.16	NS
38	34.2	1.34	34.3	1.27	NS
39	34.7	1.41	34.5	1.24	NS
40	35.1	1.38	34.6	1.14	NS
41	35.5	1.41	34.7	1.36	NS

+ + + $p < 0.001$; + + $p < 0.01$; + $p < 0.05$ NS; Baranya–II > Baranya–I
– – – $p < 0.001$; – – $p < 0.01$; – $p < 0.05$ NS; Baranya–I > Baranya–II

Table 8. **Head circumference (cm) in newborn girls**

Gestational age (weeks)	Baranya–I (Fekete et al. 1968, 1974)		Baranya–II (present study)		
	x	SD	x	SD	P
30	28.4	2.20	29.3	2.01	NS
31	29.4	2.20	29.5	1.97	NS
32	30.1	2.10	30.1	1.73	NS
33	30.8	2.20	30.9	1.81	NS
34	31.6	2.20	31.7	1.77	NS
35	32.1	1.90	32.2	1.32	NS
36	32.5	1.70	32.7	0.73	NS
37	33.0	1.60	32.9	1.35	NS
38	33.3	1.40	33.4	1.34	NS
39	33.8	1.40	33.6	1.25	–
40	34.0	1.36	33.5	1.12	– – –
41	34.3	1.44	34.0	1.39	NS

+ + + $p < 0.001$; + + $p < 0.01$; + $p < 0.05$ NS; Baranya–II > Baranya–I
– – – $p < 0.001$; – – $p < 0.01$; – $p < 0.05$ NS; Baranya–I > Baranya–II

Discussion

The birth weight in the youngest age groups (30–34th weeks) have not changed at all. The increase of birth weight in the elder age groups (35–37th and 39th weeks) during the investigated period was very small.

The decrease of birth length probably is the consequence of technical reasons. In the study of Fekete et al. (1968, 1974) the length of the baby was usually measured with a tape, a measuring table was routinly not used. In our survey the length was determined with a measuring tagle, which resulted in our experience in a shorter length. Anyhow, this tecnical error or discrepancy between the two studies does not permit to draw conclusions concerning a secular trend.

The boy's head circumferences have not changed, but the girls's values even have slightly decreased in the elder age groups (39–40th gestational weeks).

According to the results the following conclusions can be made:

(1) The differences seen in the values of some gestational age groups were biologically insignificant and did not mean a consequent tendency valid for the whole material. Secular changes in general in the newborn body measurements could not be realised during the investigated period.

(2) The intrauterine growth standards of Fekete et al. (1968, 1974) are still suitable.

(3) Since currently more dramatic social, economical and health care changes occur than in the examination period of the present paper, more expressed anthropometric alterations can be expected in the next future. Therefore repeating of the growth studies are necessary in our region.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. *33;* 171–176. (1991)

A STUDY ON THE SECULAR TREND IN YOUNG ADULTS

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Abstract: *The possible manifestation of the secular trend were analyzed on the physique of students applying for admission to the University of Physical Education, Budapest, between 1972 and 1991. The variables studied were stature, body mass and the metric and plastic indices of Conrad's growth type. The subjects were successive cohorts of physically active young adults of whom 2322 were females and 2560 were males. Polynomial regression analysis of the yearly means gave a best fit for the linear model in most of the studied variables, but several of the higher order components were also significant. The results are also discussed in respect of the previous (15-years-long) analysis.*

Key words: *Secular trend; Young athletic adults; Polynomial regression models.*

Introduction

Since 1972 the body build characteristics of the students applying for admission to the University of Physical Education, Budapest, were recorded for every successive year. During the twenty-year period until 1991, the senior authors published some reports on the physique of these young adults and also on the phenomena attributable to the secular trend after 10 and 15 years of investigation (Mészáros 1979, Mohácsi et al. 1989/1990).

Secular trend was studied not only in the P. E. students but also in students from other universities from we had data on body build variables (Frenkl and Mészáros 1979, Gyenis and Till 1981, 1986).

In addition to the mentioned studies on the secular trend in Hungary, several reports are available on similar changes from abroad.

Of these, the one on the secular trend of the Belgian university students is comparable with ours in some respects (Claessens et al 1990). They followed up secular trend changes from 1951 to 1988.

The purpose of the present study was to analyze the secular trend changes in the students applying for admission to the University of Physical Education, Budapest, across a twenty year period, namely, between 1972 and 1991.

Material and Methods

The subjects were 2322 girls and 2560 boys aged between 18 and 20. The yearly distribution of the applicants in the two sexes is demonstrated in *Table 1*.

They represented a group of youth who were physically more active than the peer group in general since they wanted to become P. E. teachers, they were not elite sportsmen, though.

Body dimensions were recorded under laboratory conditions observing the recommendations of the IBP (Weiner and Lourie 1969).

The metric and plastic indices describing the growth type of Conrad (1963) were calculated by regression formulae.

Table 1. **The yearly distribution of the applicants in the two sexes**

Year	Females	Males
1972	124	111
1973	132	102
1974	112	127
1975	123	141
1976	120	112
1977	118	106
1978	102	160
1979	92	120
1980	81	101
1981	118	119
1982	112	114
1983	109	113
1984	99	108
1985	110	113
1986	126	137
1987	124	154
1988	131	159
1989	144	162
1990	131	162
1991	114	139
Sum total	2322	2560

After obtaining the yearly means and standard deviations for both sexes the trends for stature, body mass, and the Conrad indices were analyzed by orthogonal polynomials up to the fifth power. The recorded years of the application served as the independent variable.

Results and Discussion

Figure 1 shows the means and SDs of stature for the two sexes from 1972 to 1991. The values for the *stature* are scaled on the vertical axis. The open circles show the values of the girls while the bold circles demonstrate those of the boys.

In the lower part the significant components of the orthogonal polynomials can be seen along with the multiple correlation coefficients. In the series of stature means the linear trend was significant both for the girls and the boys.

In *Figure 2* the means and SDs for *body weight* are shown. A statistically significant linear trend of increase also could be proved for body weight in both sexes but the relationship seems to be less close, especially for the boys, as shown by multiple correlation.

Figure 3 shows the analysis of the successive *metric index* values. The scale on vertical axis refers to the linearity of the body build.

People having more linear body build are assigned a more negative number, stouter ones have more positive scores.

The girls showed a simple linear trend with a moderately high multiple correlation. In contrast, several higher-order orthogonal components also turned out to be significant in the boys, i.e. in addition to the linear trend the third, fourth and the fifth power components, as well.

The dominating trend of the changes was, however, the linear one. The multiple correlation in the boys showed a stronger relationship.

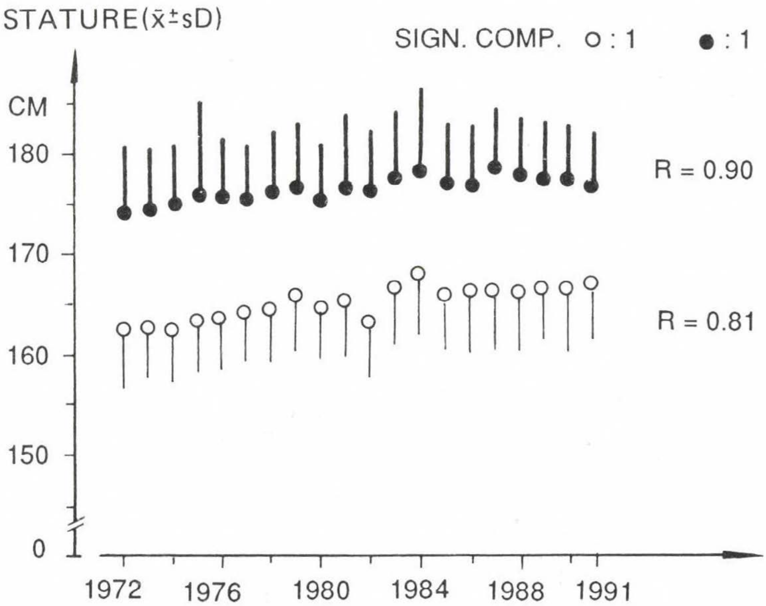

Figure 1: The means and SDs of stature of the applicants, where: bold circles – the results of the males; open circles – the results of the females. R = multiple correlation coefficient; sign. comp.: the results of the orthogonal polynomials

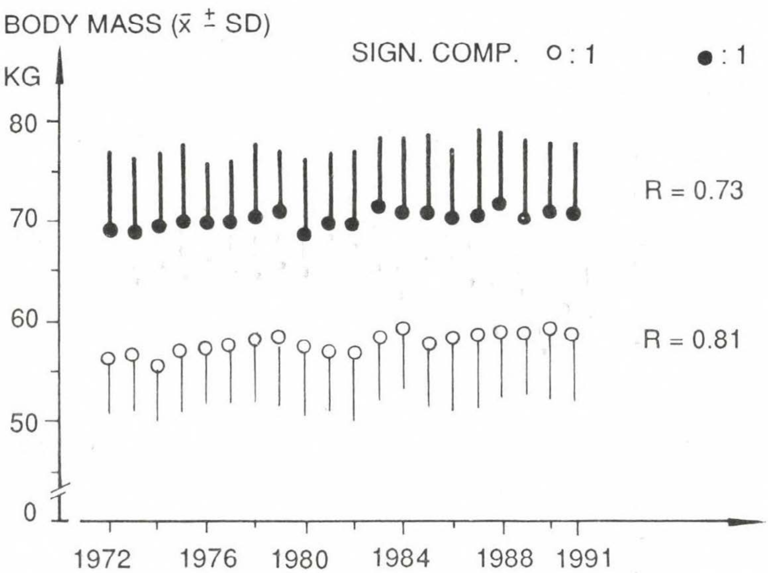

Figure 2: The means and SDs of the body mass in the two sexes. Abbreviations and the signs are the same as in Fig. 1

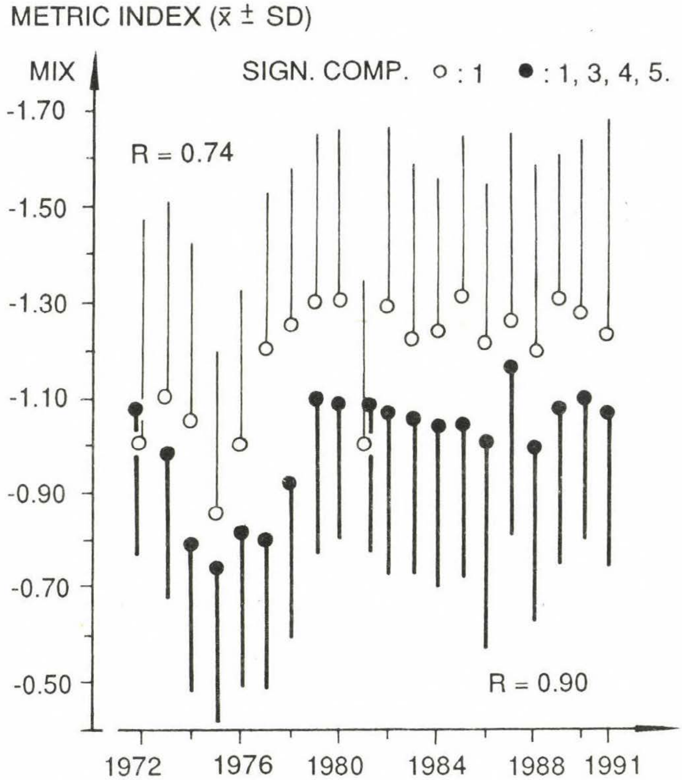

Figure 3: The means and SDs of the metric index values in the two sexes. Abbreviations and the signs are the same as in Fig. 1

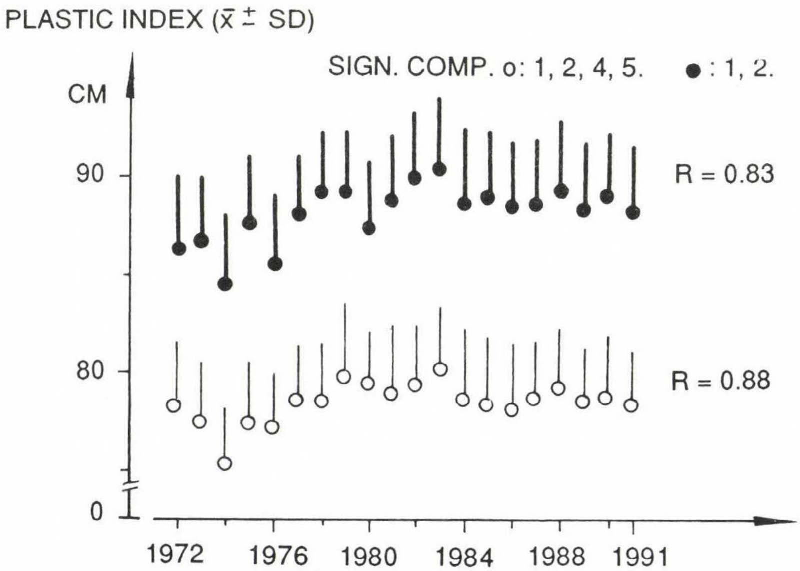

Figure 4: The means and SDs of the plastic index values in the two sexes. Abbreviations and the signs are the same as in Fig. 1

Figure 4 shows the values for the *plastic index* in the two sexes. The series of the means did not follow a simple trend as shown by the significance tests. In the girls the quadratic component was the main one.

Besides, the linear trend of the changes, the fourth and the fifth power fits were also significant.

As for the boys, however, the linear trend was dominant with an important quadratic contribution.

When speaking about secular changes and trends, we have to take into account all the effects that would modify body build.

Such influences may come from our natural, as well as social environment (Eiben 1988, Eiben and Pantó 1981).

In our study we tried to describe the nature of such changes in young adults, namely in the students applying for admission to the University of Physical Education.

In this preselected group we supposed we could confirm the existence of some trends as continuations of our former findings demonstrated 10 and 5 years before.

In the majority of studies on the secular trend body height and weight are the most often analyzed factors (Mészáros 1979, Mohácsi et al. 1989/1990).

As regard of stature as well as body mass a significant linear trend was found for both the girls and the boys during the twenty years studied.

These results corroborate thus our previous data reported for the 15-year period (Mohácsi et al. 1989/1990).

The trend for the metric index in the boys contained several higher-order components, though the main trend was linear one toward the more negative values. The results in the girls showed a simple linear trend of decrease only.

When a trend shows a multicomponent nature, it is more advisable to think it over and try to interpret it very carefully.

Since the main component was the linear change, it seems that the linearity of the body build in the boys increased with some oscillations along that line.

We are not sure that it can be explained easily and exactly by reasons, other than random fluctuation.

In the plastic index it was the group of the girls where such phenomena were found.

The dominant component was the quadratic trend in the girls, but the linear, fourth and fifth power components also contributed to it significantly.

In the boys the main linear trend was coloured by a significant quadratic component.

In our previous report concerning the 15-year period, the most marked component was a linearly increasing trend. The dominance of the quadratic component in the present material means that during the last five years the formerly linear increase in the plastic index of the girls levelled off.

Our results allow the conclusion that the existance of the linear trend could be demonstrated in every studied parameter (Gyenis and Till 1986). The situation is the same also when observing data from abroad (Claessens et al. 1990). In that investigation also a significant linear trend of changes in the body build characteristics was reported during that period simirlarly to our findings.

It was only the girls' plastic index in which the quadratic was the main significant component.

These observations agree with the most of our former results and demonstrate a continuation of the secular trend.

The essence of these is that young male adults have become taller and more robust, but slightly more linear.

The young adult females of our material also grew taller, heavier and more linear, but their increase of robustness came to an end.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 3 November, 1991.

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Anthrop. Közl. *33;* 177–183. (1991)

REFERENCE DATA OF TWO SKINFOLD THICKNESSES (TRICEPS AND SUBSCAPULAR) FOR BOYS AND GIRLS FROM BIRTH TO THE AGE OF SIX YEARS, BASED ON A NATIONAL REPRESENTATIVE GROWTH STUDY

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Abstract: *Two types of skinfold thicknesses (triceps and subscapular) of 5675 Hungarian children (2993 boys and 2682 girls) were measured using Lange skinfold caliper at the age of 0–6 years in a national representative longitudinal research "Health and demographic growth study of pregnant women and infants".*

Means, standard deviations and percentiles of skinfold thicknesses are determined at single ages. Average values of boys are compared to those of girls. From birth to 2 years there is no significant difference between the skinfold averages of the two sexes. Later at 3, 4, 5 and 6 years the average values of girls are significantly higher compared to the boys.

Key words: *Triceps and subscapular thicknesses; AGA, SGA, LGA children.*

Introduction

In Hungary the measurement of skinfold thickness became a widespread tool for determining the nutritional level of adults and children of various ages in the last decade (Eiben and Pantó 1987/88, Blatniczki et al. 1988). In our paper we intend to complete the public results of the cross-sectional research work with the skinfold reference values of infants and small children.

Materials and Methods

The measurement of skinfold thickness in children forms a part of the nation-wide longitudinal study "Health and demographic growth study of pregnant women and infants" currently in progress. Examinations carried out between birth and 6 years of age involved also triceps and subscapular skinfold thickness measurements made by Lange-type caliper.

For the elaboration of the reference values only data of children born with weights between 2500–4500 g and who did not have long-lasting disease influencing their growth and development 2993 boys, 2682 girls at birth; 2469 boys and 2197 girls at the age of 6 years have been used. The number of children according to the classification of newborn by birth weight and gestational age show the *Table 1*. In the first six months of life the measurements were performed in each month, until one year bimonthly once, then during the second year trimonthly; and between 2 and 6 years once a year.

Table 1. **Number of children according to the classification of newborn by birth weight and gestational age**

Group of children	At birth		At the age of 6 years	
	Boys	Girls	Boys	Girls
SGA	265	284	202	218
AGA	2452	2235	2006	1793
LGA	313	269	257	217

Results and Discussion

The results of the yearly measurements from birth to six years are shown in the *figures 1–4,* however, by the statistical calculations the values of the intermediate measurements were also taken into consideration.

The *percentile values* of triceps and subscapular skinfold thicknesses are approximately identical at birth. From the age of 1 year the differences are getting more and more striking. The 50th percentile of subscapular skinfold is by 3 mm less than the triceps skinfold (*Fig. 1–4*).

The *triceps skinfold* reference averages of boys and girls well demonstrate that the skinfold thickness found at birth doubled by the end of the first year of age. Thereafter, until the age of 6 years, no such drastic changes take place. With the girls some increase, while with the boys a decrease in the skinfold can be observed. From birth to 2 years there is no significant difference between the skinfold averages of the two sexes. However, later at 3, 4, 5 and 6 years the average values of boys and girls differ strongly significantly (*Fig. 5*).

The *subscapular skinfold* thickness averages increase only with 75% by 1 year. Later, the skinfold thickness averages of girls decrease in smaller degree compared to those of the boys. By 2 years of age these averages are significantly higher in girls than in boys. At 3, 4, 5 and 6 years of age the difference of average values is highly significant (*Fig. 6*).

Furtheron we investigated how the birth weight does influence the difference of the average values of males and females. As it is known the Small for Gestational Age (SGA), Appropriate for Gestational Age (AGA), and Large for Gestational Age (LGA) groups have been formed considering the 10th and 90th percentile limit values of birth weight by gestational age (Battaglia and Lubchenco 1967, Joubert 1983).

The triceps and subscapular averages of *AGA newborns* well demonstrate that the decline of the curves is nearly identical with that of the reference averages curves. According to this, the yearly averages of triceps skinfold values of the two sexes differ highly significantly at 3, 4, 5 and 6 years, while those of subscapular values have a strongly significant difference already in the 2nd year of life (*Fig. 7*).

In the *SGA group of newborns* the average triceps values of boys at one year show significant difference. With the advance of years their averages decrease, while those of the girls increase, by the age of 5 and 6 years the difference becomes significant (*Fig. 8*). Both in males and females the subscapular averages show a sinking tendency – in boys a stronger one – after one year. This difference proves to be significant at the age of 3 years, later it becomes strongly significant.

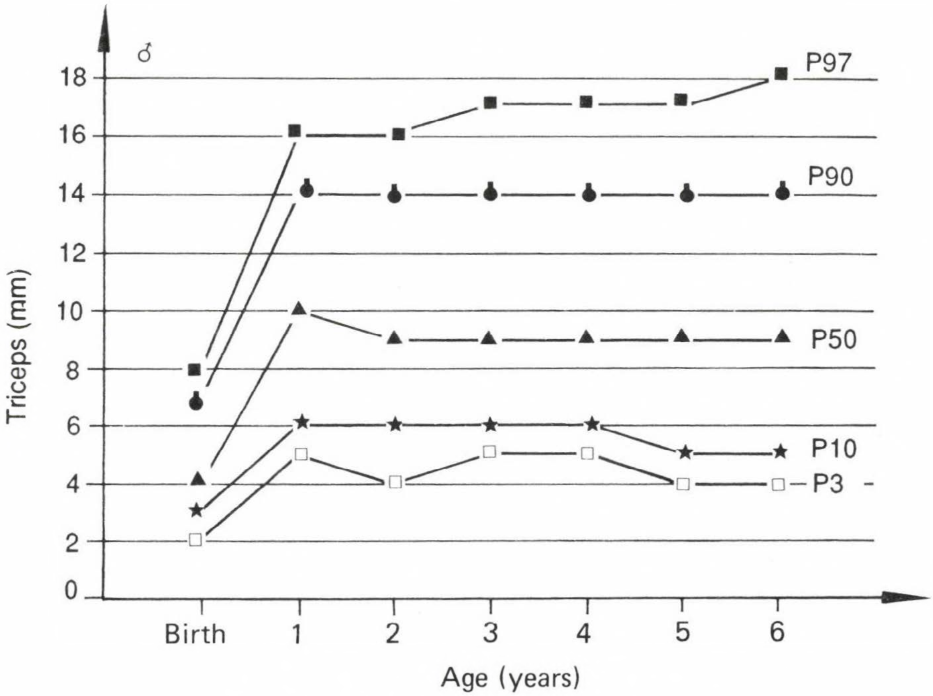

Fig. 1: Percentiles for triceps skinfold thickness of boys

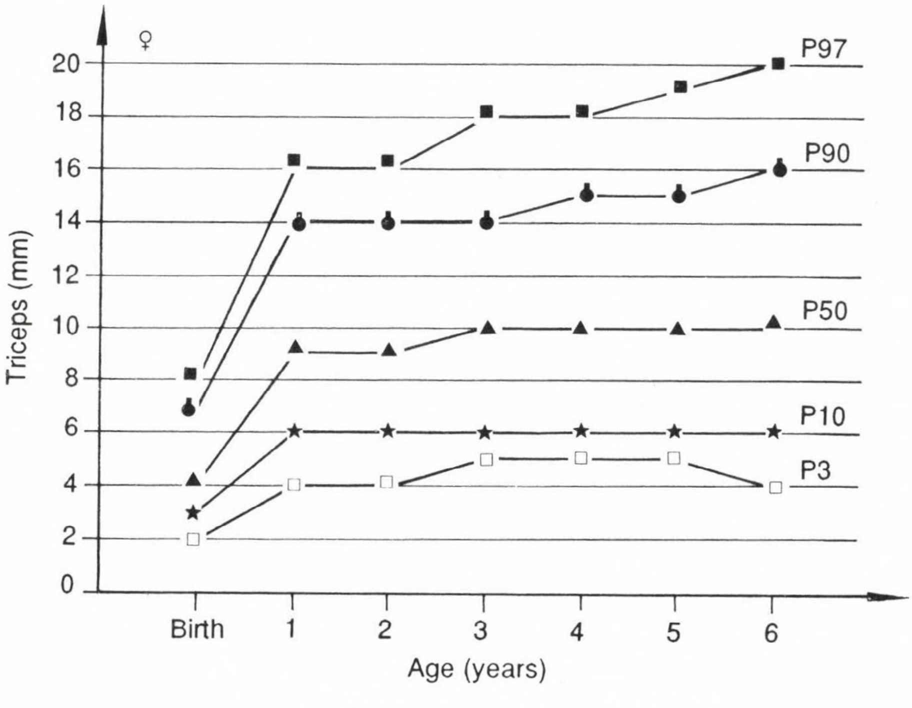

Fig. 2: Percentiles for triceps skinfold thickness of girls

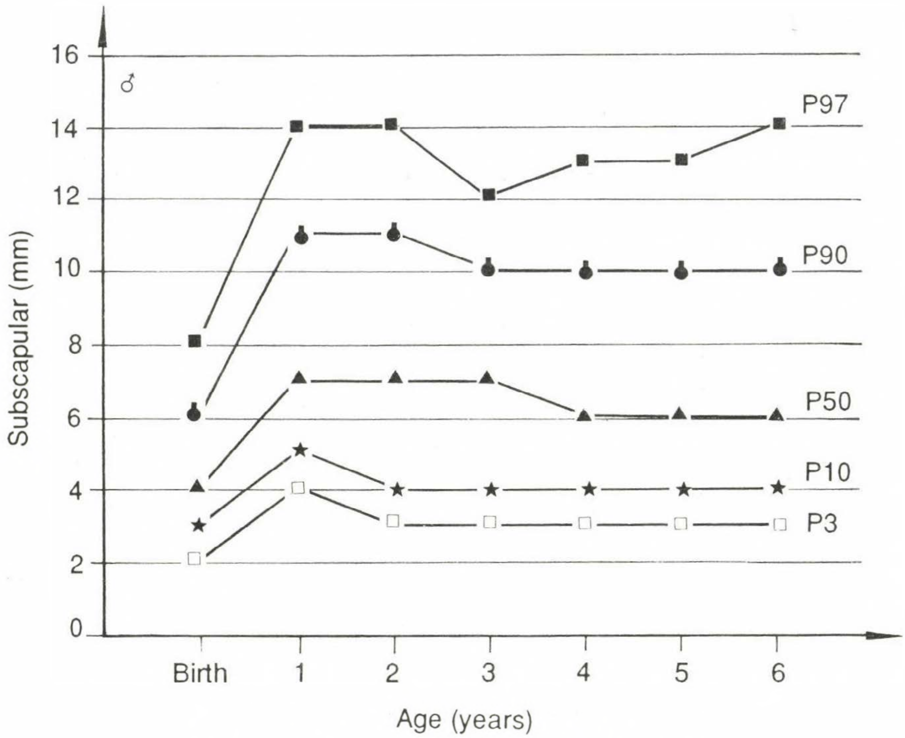

Fig. 3: Percentiles for subscapular skinfold thickness of boys

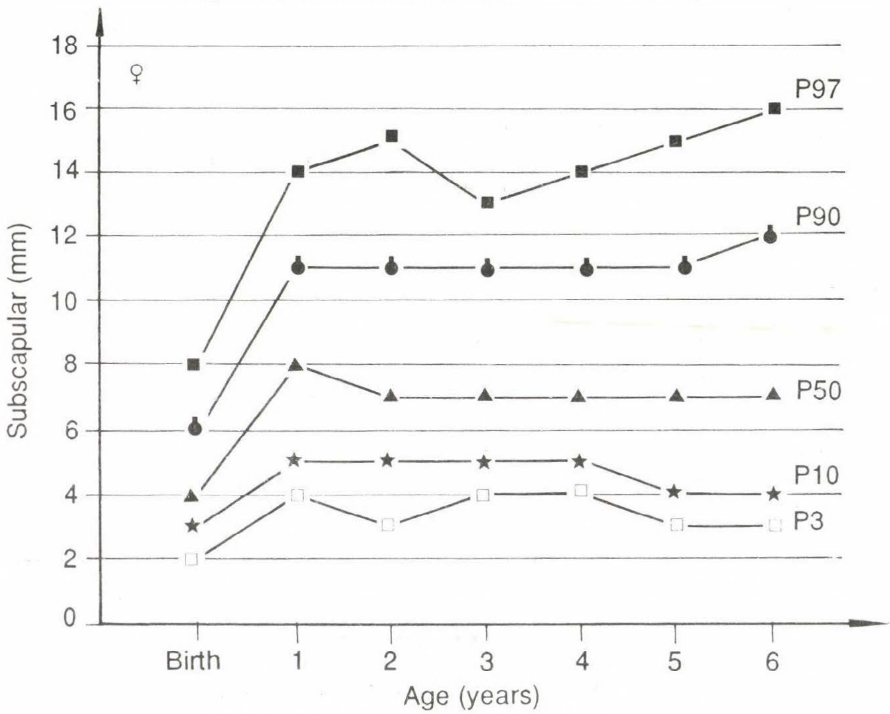

Fig. 4: Percentiles for subscapular skinfold thickness of girls

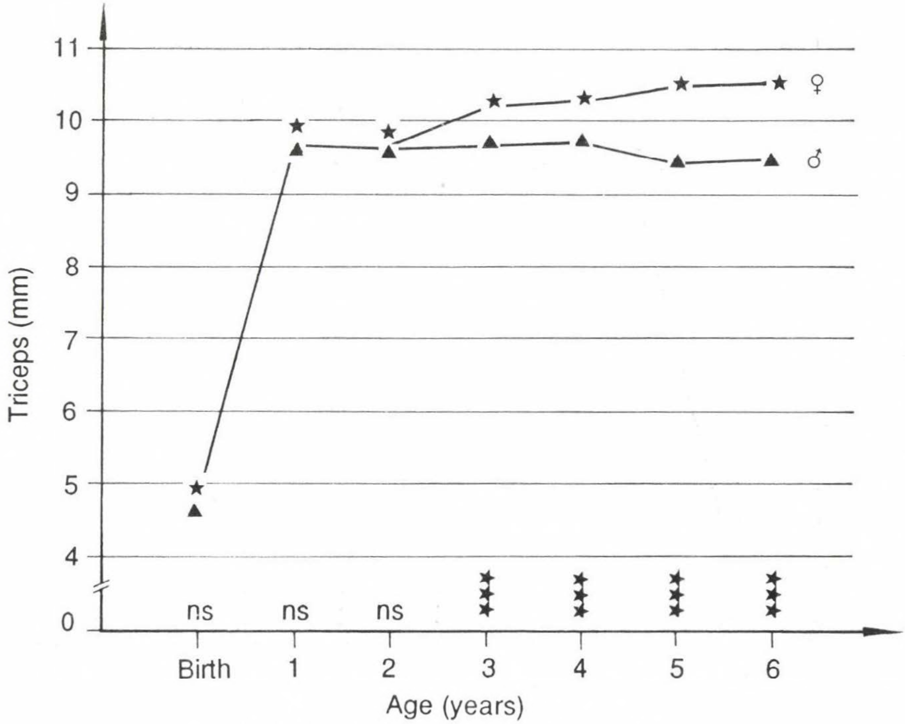

Fig. 5: Triceps skinfold thickness of boys and girls
(* P < 0.05; ** P < 0.01; *** P < 0.001; n. s. = not significant)

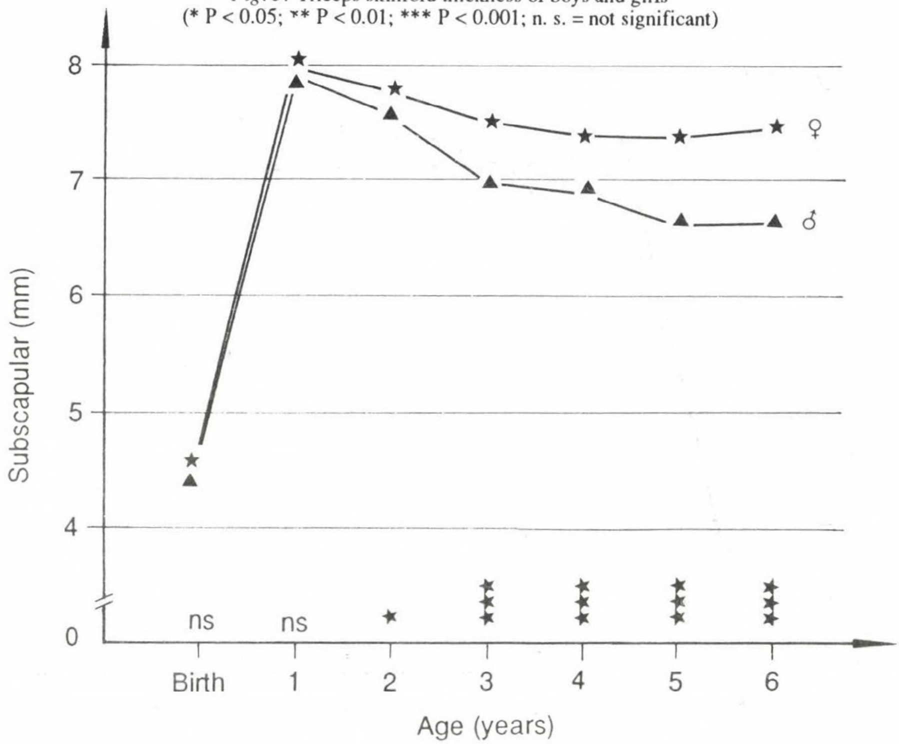

Fig. 6: Subscapular skinfold thickness of boys and girls
(* P < 0.05; ** P < 0.01; *** P < 0.001; n. s. = not significant)

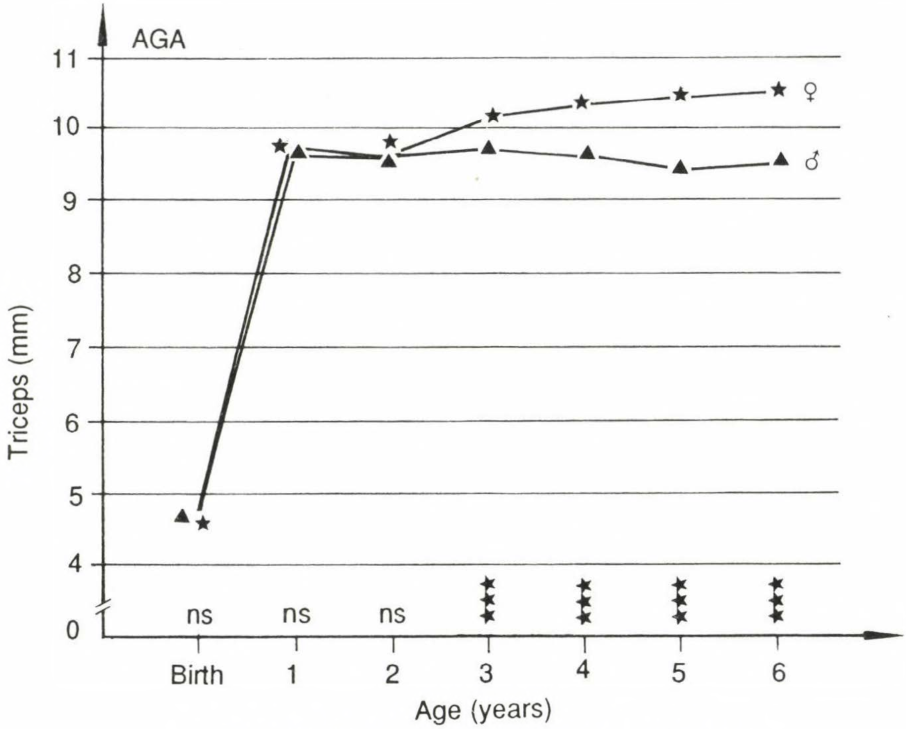

Fig. 7: Boys' and girls' triceps skinfold thickness in AGA group
(* P < 0.05; ** P < 0.01; *** P < 0.001; n. s. = not significant)

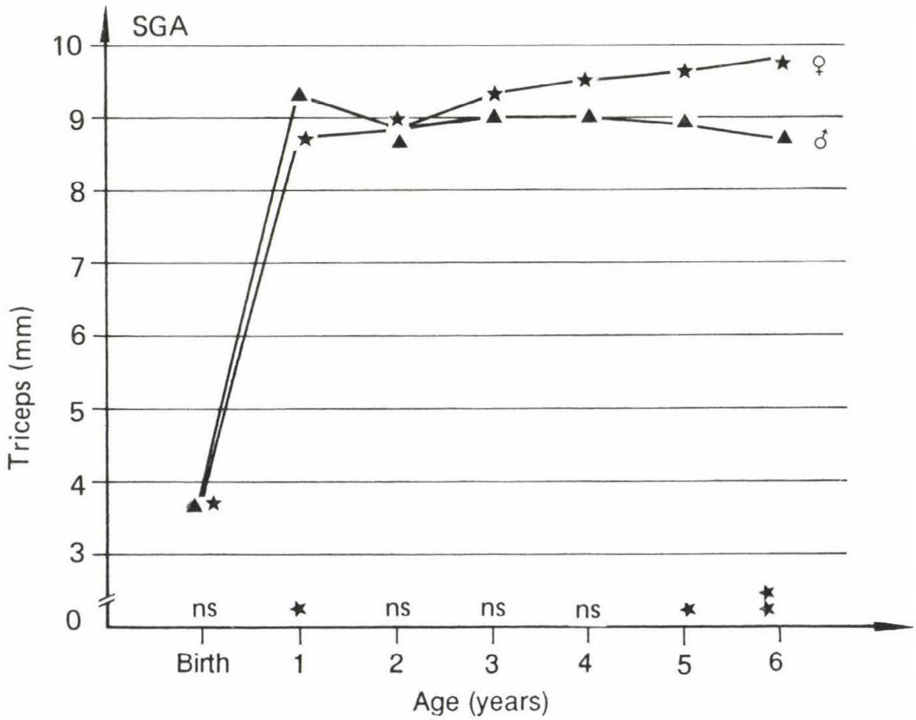

Fig. 8: Boys' and girls' triceps skinfold thickness in SGA group
(* P < 0.05; ** P < 0.01; *** P < 0.001; n. s. = not significant)

In the LGA group a similar tendency can be experienced, both the triceps and subscapular averages of males compared to females exhibit a significant difference beginning from 4 years of age.

We presented the first Hungarian triceps and subscapular reference percentiles from birth to the age of 6 years. We stated that from 3 years both the triceps and subscapula averages are strongly significantly higher in girls than in boys.

Investigating the difference of skinfold thicknesses by the birth weight groups, it can also be stated that the girls' averages between the ages of 3 and 6 years are significantly higher compared to the boys.

*

Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 31 July, 1991.

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Anthrop. Közl. *33;* 185–191. (1991)

SKINFOLD THICKNESSES (TRICEPS AND SUBSCAPULAR) OF INFANTS OF LOW BIRTH WEIGHT COMPARED TO THE REFERENCE DATA FROM BIRTH TO THE AGE OF SIX YEARS

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Abstract: *Data of this study came from a national representative longitudinal growth research: "Health and demographic growth study of pregnant women and infants."*

Two types of skinfold thicknesses (triceps and subscapular) of 413 infants of low birth weight (185 boys and 228 girls) are included in this report. Means of these measurements are compared to the reference values. Average skinfold thicknesses referring to infants of low birth weight are lower than that of the reference group at all ages between birth and 6 years.

The average skinfold of low birth weight babies are significantly (p < 0.001) less than the reference values at triceps for boys of 0–8 months old, at subscapular for 0–4 months old boys. The same significant differences were found also for girls at triceps to the age of 3 months, at subscapular up to 2 months. Size of differences was investigated according to the classification of newborn by birth weight and gestational age (SGA, AGA, LGA).

Key words: *Triceps and subscapular skinfold thicknesses; Low birth weight infants; SGA, AGA, LGA infants.*

Introduction

In Hungary the measurement of skinfold thickness became a widespread tool for determining the nutritional level of adults and children of various ages in the last decade (Eiben and Pantó 1987/88, Blatniczki et al. 1988). In our paper we intend to complete the public results of the cross-sectional research work with the skinfold reference values of infants and small children.

Material and Methods

The data of this presentation derive from the nation-wide longitudinal representative research program: "Health and demographic growth study of pregnant women and infants", from the section of child growth (Joubert et al. 1986, Joubert and Gárdos 1991).

We report on the skinfold thickness averages of children belonging to the reference group and born with body weights lower than 2500 g according to the conventional birth weight categorization, and the skinfold averages of SGA (Small for Gestational Age), AGA (Appropriate for Gestational Age), LGA (Large for Gestational Age) children compared to each other. The number of investigated children is shown in *Table 1*. The SGA, AGA and LGA groups have been formed considering the 10th and 90th percentile limit values of birth weight by gestational age (Battaglia and Lubchenco 1967, Joubert 1983).

Table 1. **Number of investigated boys and girls**

		At birth	At the age of 6 years
Number of children for reference data (birth weight 2500–4499 g)		2993 boys 2682 girls	2469 boys 2197 girls
Number of childrem with low birth weight (birth weight –2499 g)		185 boys 228 girls	144 boys 175 girls
Number of children according to the classification of newborn by birth weight and gestational age	SGA	265 boys 284 girls	202 boys 218 girls
	AGA	2452 boys 2235 girls	2006 boys 1793 girls
	LGA	313 boys 269 girls	257 boys 217 girls

Results

The yearly *triceps* skinfold averages of boys, respectively who are members of the reference group and were born with low body weights are demonstrated in *Fig. 1*. The difference between the averages was calculated by *t*-test in each age examined.

In boys there is a very strongly significant difference from birth to the age of 8 months and at 5 years, but at the age of one year, 15 months and 3 years the averages of the two groups do not differ significantly. In girls the triceps averages are very significantly different at birth and in the first 3 months, later this difference becomes ever smaller and in several cases at the age of 0.5, 1.5, 3, 4 and 6 years no statistically evaluable difference can be found (*Table 2*).

Table 2. **Results of *t*-test of triceps skinfold thickness in Reference groups and in Low birth weight (Lbw) groups**

Age		Boys Reference and Lbw	Girls Reference and Lbw
Birth		* * *	* * *
1	month	* * *	* * *
2	month	* * *	* * *
3	month	* * *	* * *
4	month	* * *	* *
5	month	* * *	*
6	month	* * *	n. s.
8	month	* * *	* *
10	month	*	* *
12	month	n. s.	* *
15	month	n. s.	*
18	month	* *	n. s.
21	month	* *	*
24	month	* *	* *
3	year	n. s.	n. s.
4	year	* *	n. s.
5	year	* * *	*
6	year	* *	n. s.

* $p < 0.05$, * * $p < 0.01$, * * * $p < 0.001$, n. s. = not significant

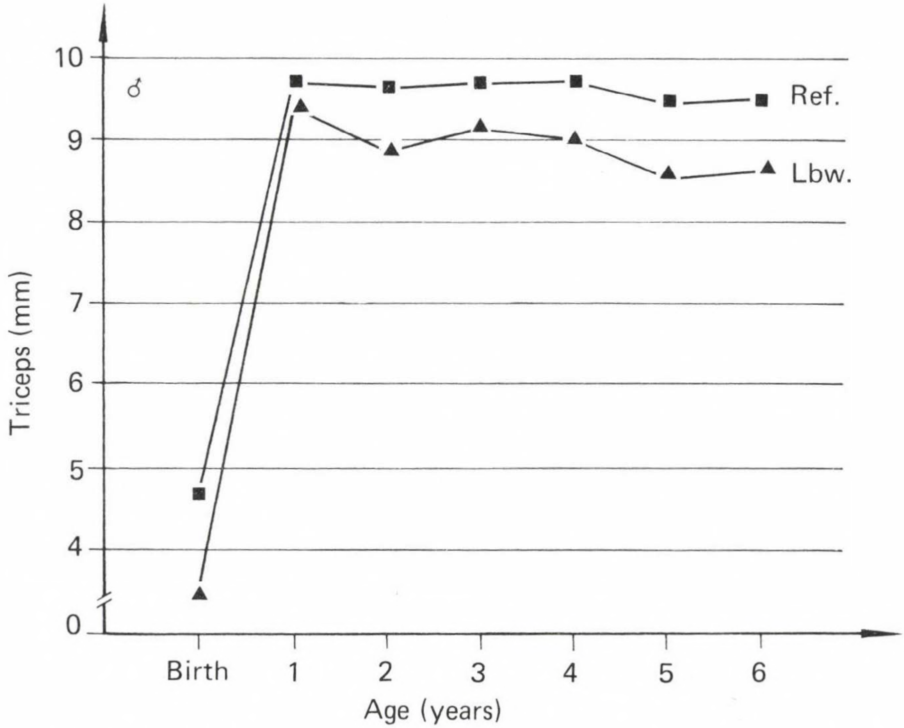

Fig. 1: Comparison of boys' triceps skinfold thickness in reference (Ref.) and low birth weight (Lbw) groups

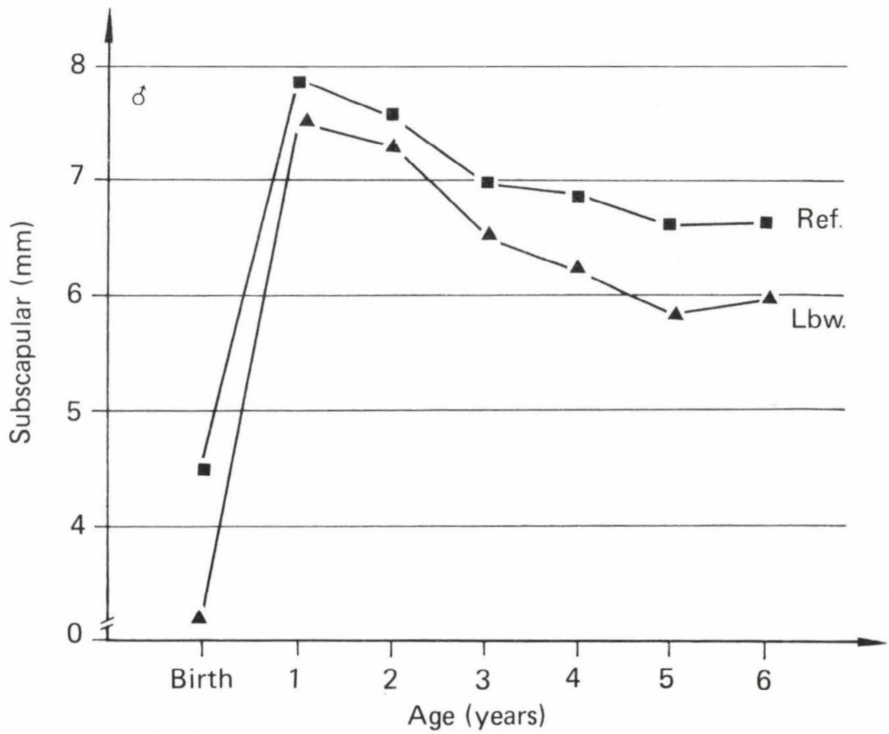

Fig. 2: Comparison of boys' subscapular skinfold thickness in reference (Ref.) and low birth weight (Lbw) groups

The mean *subscapular* values of boys born with low body weight and belonging to the reference group can be seen in *Fig. 2*

In boys the difference of subscapular skinfold thickness averages is strongly significant at birth, at the age of 4 months and 5 years. At other times, however, statistical difference can be experienced only in some cases. The girls' average values differ significantly at birth and in the first 3 months. However, at the age of 4, 5, 6 months and 5, 6 years there is no significant difference between the averages of the groups examined. The average values measured at various ages during the intercurrent time show differences of various levels of significance (*Table 3*).

Table 3. **Results of *t*-test of subscapular skinfold thickness in Reference groups and in Low birth weight (Lbw) groups**

Age		Boys	Girls
		Reference and Lbw	Reference and Lbw
Birth		* * *	* * *
1	month	* * *	* * *
2	month	* * *	* * *
3	month	* * *	* *
4	month	* * *	n. s.
5	month	*	n. s.
6	month	n. s.	n. s.
8	month	*	*
10	month	n. s.	* *
12	month	n. s.	* * *
15	month	n. s.	*
18	month	n. s.	* * *
21	month	*	* * *
24	month	n. s.	* * *
3	year	*	*
4	year	* *	*
5	year	* * *	n. s.
6	year	*	n. s.

* $p < 0.05$, * * $p < 0.01$, * * * $p < 0.001$, n. s. = not significant

In the following part of our paper we report on the skinfold averages of SGA, AGA and LGA children compared to each other.

The triceps values of boys significantly differ at all ages – only the level of significance is varying – if the SGA and AGA groups are compared. The difference of the AGA and LGA children's averages is significant only at birth and in the next 3 months.

In girls – similarly to the boys – the comparison of SGA and AGA groups from birth to the age of 6 years yields significant difference. The comparison of AGA and LGA averages results in non-significant difference only after the age of one year, while in boys it is non-significant already from 3 months of age (*Table 4*).

The subscapular skinfold thicknesses in boys and girls groupped as SGA, AGA and LGA children are demonstrated in *Fig. 3* and *4*. The related curves of SGA–AGA groups differ from those of triceps only at one time – at the age of 15 months – when the difference does not reach the lower level of significance stated by us. The difference of AGA–LGA comparative values proves to be significant at birth, at the age of 2 and 15 months. In girls born with various body parameters the subscapular skinfold averages measured at various ages show similar correlation as was found with the boys (*Table 5*).

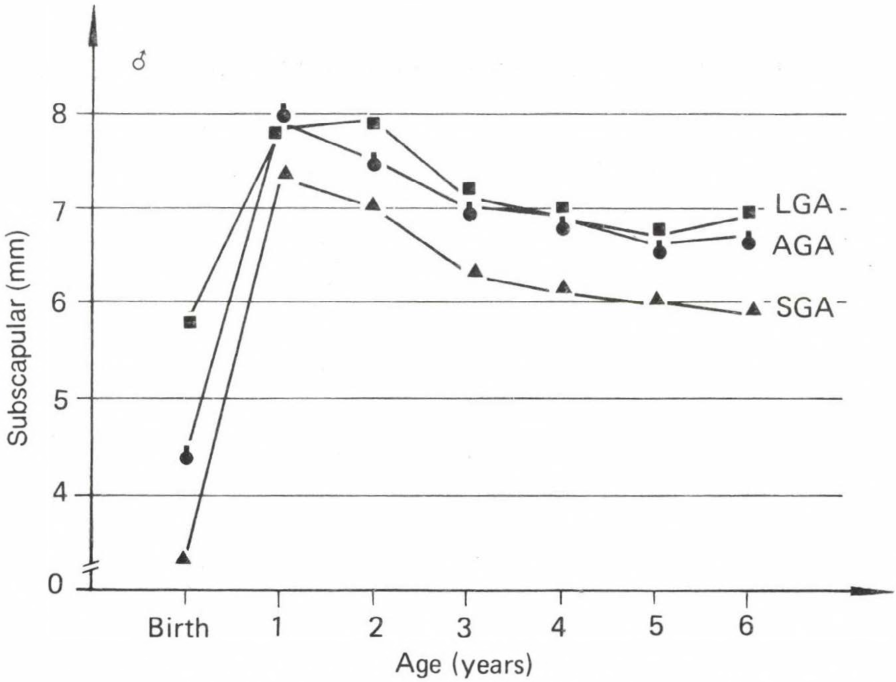

Fig. 3: Subscapular skinfold thickness of boys in LGA, AGA, SGA groups

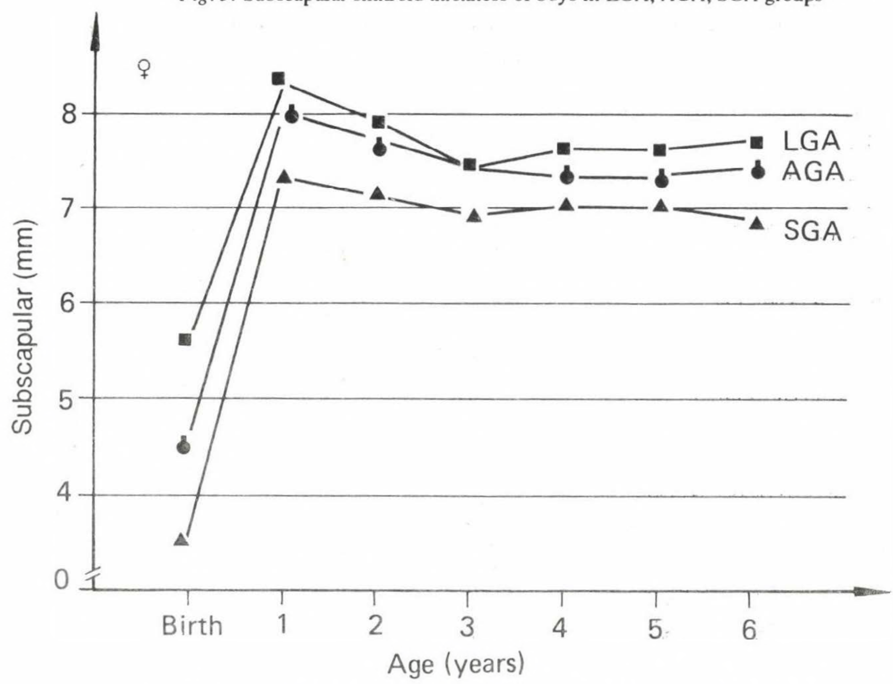

Fig. 4: Subscapular skinfold thickness of girls in LGA, AGA, SGA groups

Table 4. **Results of *t*-test of triceps skinfold thickness in SGA, AGA, LGA groups**

Age	Boys			Girls		
	AGA–SGA	AGA–LGA	SGA–LGA	AGA–SGA	AGA–LGA	SGA–LGA
Birth	* * *	* * *	* * *	* * *	* * *	* * *
1 month	* * *	* * *	* * *	* * *	* * *	* * *
2 month	* * *	* * *	* * *	* * *	* *	* * *
3 month	* * *	*	* * *	* *	* *	* * *
4 month	* * *	n. s.	* * *	* *	*	* * *
5 month	* * *	n. s.	* *	* *	*	* * *
6 month	* * *	n. s.	* *	* * *	n. s.	* * *
8 month	* * *	n. s.	* *	* * *	* *	* * *
10 month	* *	n. s.	* *	* * *	n. s.	* * *
12 month	*	n. s.	n. s.	* * *	*	* * *
15 month	*	n. s.	n. s.	* *	n. s.	* * *
18 month	* *	n. s.	n. s.	* * *	n. s.	* * *
21 month	* *	n. s.	*	* * *	n. s.	* * *
24 month	* * *	n. s.	* * *	* * *	n. s.	* * *
3 year	* * *	n. s.	* * *	* *	n. s.	* * *
4 year	* *	n. s.	* * *	* *	n. s.	* * *
5 year	*	n. s.	*	* *	n. s.	* * *
6 year	* *	n. s.	* *	* *	n. s.	* *

* $p < 0.05$, * * $p < 0.01$, * * * $p < 0.001$, n. s. = not significant

Table 5. **Results of *t*-test of subscapular skinfold thickness in SGA, AGA, LGA groups**

Age	Boys			Girls		
	AGA–SGA	AGA–LGA	SGA–LGA	AGA–SGA	AGA–LGA	SGA–LGA
Birth	* * *	* * *	* * *	* * *	* * *	* * *
1 month	* * *	* * *	* * *	* * *	* * *	* * *
2 month	* * *	* *	* * *	* * *	n. s.	* * *
3 month	* * *	n. s.	* * *	* * *	n. s.	* * *
4 month	* * *	n. s.	* * *	*	n. s.	n. s.
5 month	*	n. s.	*	*	n. s.	*
6 month	* *	n. s.	n. s.	* *	n. s.	* *
8 month	* *	n. s.	* *	* *	n. s.	* *
10 month	*	n. s.	n. s.	* * *	n. s.	* *
12 month	* * *	n. s.	*	* * *	n. s.	* * *
15 month	n. s.	n. s.	n. s.	* *	*	* * *
18 month	*	n. s.	*	* * *	n. s.	* * *
21 month	*	n. s.	* *	* *	n. s.	* * *
24 month	* *	*	* * *	* *	n. s.	* *
3 year	* * *	n. s.	* * *	* *	n. s.	*
4 year	* * *	n. s.	* * *	n. s.	n. s.	*
5 year	* * *	n. s.	* *	n. s.	n. s.	*
6 year	* * *	n. s.	* * *	*	n. s.	*

* $p < 0.05$, * * $p < 0.01$, * * * $p < 0.001$, n. s. = not significant

Both the triceps and subscapular skinfold averages if compared the data of SGA and LGA groups, yield similar correlation as stated when studying the averages of SGA and AGA children.

Discussion

The difference between the skinfold averages of low birth weight children belonging to the reference group is strongly significant from birth to the age of a few months, then this difference is decreasing, though not uniformly, and with the boys remains significant to the age of 6 years. Comparing the difference of skinfold averages of children with various birth weights it can be stated that the SGA and AGA groups differ strongly significantly at each age. It supports the fact we established by the measurement of body weight (mass), body length (height), head and ches circumference that the birth weight calculated for gestational age may have an influence on the body development at least to the age of 6 years.

At the same time the above mentioned relationship give the explanation, why the only parameter of birth weight and the corresponding groupping (low birth weight and reference group) does not give an unambigous relationship at all ages. Namely, it this case the aspect of groupping is too simple and one-sided compared to the SGA–AGA–LGA system.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 31 July, 1991.

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Anthrop. Közl. *33;* 193–202. (1991)

EFFECT OF STONE DUST ON MORPHO-PHYSIOLOGICAL FUNCTIONS IN MALIS OF RAJASTHAN

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Abstract: *In order to study the impact of stone dust exposure on physiological functions, physical fitness, body size and physique, data were collected from 250 adult (125 males and 125 females) Malis working in stone quarries of Rajasthan. For comparison, 250 adult (125 males and 125 females) Malis dealing in dairy products were taken. It both the sexes, the stone quarry workers have lower FVC,* FEV_1 *and PEFR than the controls. The stone quarry workers are less fit, have lower grip strength, higher blood pressure and pulse rate than the Pastoral Malis. Differences between the two groups are marginal in linear dimensions, but the stone quarry workers are lighter, having smaller breadths, circumferences and skinfolds than controls. The exposed workers have lower mesomorphic and endomorphic components and higher ectomorphic component than the controls.*

It has been concluded that the dust particles of respirable fraction emitted during the process of grinding, milling and blasting, can enter and get deposited in the respiratory tract and lungs and obstruct functioning of airways. This results in lower lung functions producing adverse effects on cardiovascular system, physical fitness, strength, and to some extent on body size and physique.

Key words: *Body measurements; Somatotype; Morpho-physiological functions; Lung function; Physical fitness; Malis of Rajasthan.*

Introduction

Increasing attention is being paid in India to improve working conditions and maintain regulations related to occupational health, but the efforts are still inadequate, perhaps because of numerous difficulties. One of them is certainly the non-availability of accurate data on occupational health and accidents. For example, dust control measures and regular medical examinations are still almost invariably absent in stone quarries, specially the small ones situated remotely. On the other hand, health hazards related to dust exposure of various types of organic and inorganic dusts are well documented (Amandus et al. 1989, Balmes et al. 1990, Cotton et al. 1983, Jorensen et al. 1981 Lee, 1989, Shah et al. 1983, Sharma and Singh 1990).

The present study aims to examine the effects of stone dust exposure on lung functions, pulse rate, blood pressure, grip strength, physical fitness, body measurements and somatotypes using data from stone quarry workers of Rajasthan (India).

Material and Methods

The study was conducted in Alwar district of Rajasthan (*Fig. 1*). The district has a dry climate with hot summer, a cold winter and a short monsoon season. The temperature ranges from 8 °C to 45 °C, with mean annual temperature around 26 °C. Data were collected on the endogamous group of Malis. The exposed group comprised 125 adult males and 125 adult females working actively in different stone quarries in Alwar district. The control group consisted 125 adult males and 125 adult females. The members of the control group trade in milk and its products. They are similar in age, smoking habits and social habits, except those created by their respective work environment.

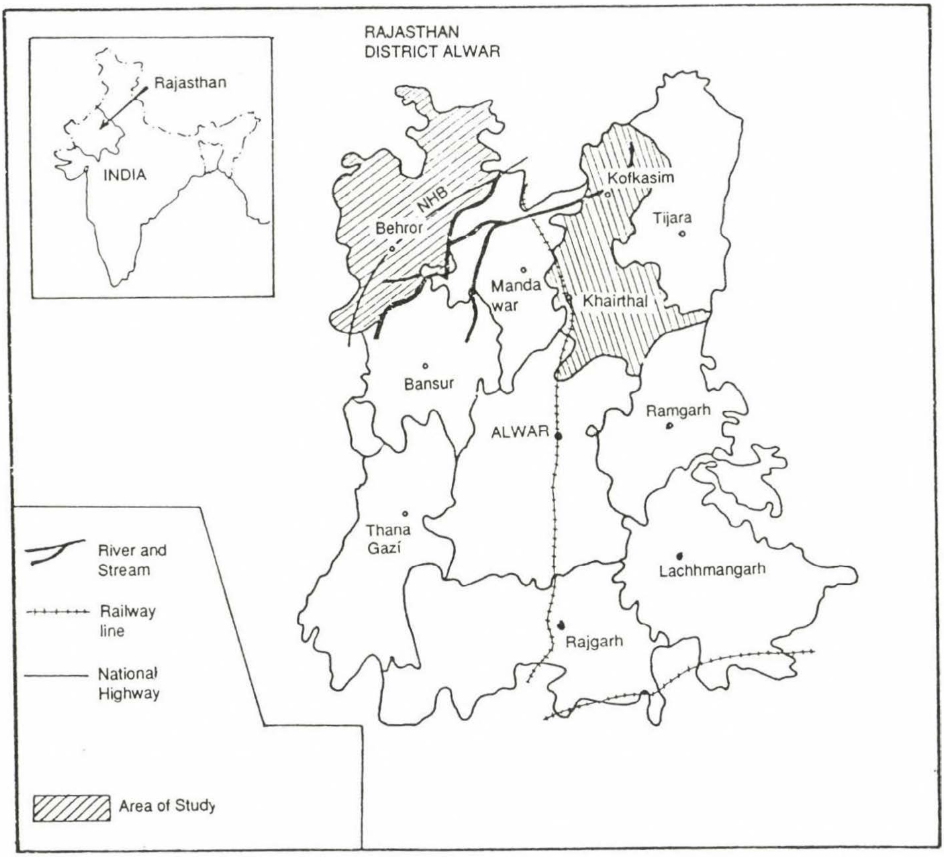

Fig. 1: Map of Alwar district showing area of study

Forced vital capacity (FVC), forced expiratory volume 1st second (FEV_1) and peak expiratory flow rate (PEER) were measured in sitting position with Morgan's portable spirometer following standard technique (Consolazio et al. 1963, Cotes 1975, Weiner and Lourie 1969). Best of three attempts were taken for further analysis.

Indirect ausculatory method was used for taking blood pressure in sitting position. Pulse rate and blood pressure were taken as per the recommendation of International Biological Program (Weiner and Lourie 1969).

Hand grip strength of right and left hands were taken with a dynamometer and recorded in kilograms (Weiner and Lourie 1969). The subjects were encouraged to press the maximum keeping the active arm in hanging position, close to the body but not touching it.

Physical fitness was evaluated using the famous Harvard step test, described in detail by Hockey (1973). This test is most suitable for measuring cardio-vascular endurance of subjects under field conditions. The test' is based on the premise that, for a given submaximal work, a person with higher physical fitness will have a smaller increase in heart rate and a faster recovery rate. Rapid fitness index was calculated using the formula:

$$\text{RFI} = \frac{\text{Duration of exercise (in seconds) x 100}}{\text{5.5 x Pulse count from 1 to 1.1/2 min. after exercise}}$$

Body measurements were taken following standard techniques (Tanner et al. 1969). Subjects were somatotyped from ten anthropometric measurements using Heath and Carter's method (Carter 1975, Heath and Carter 1967). Somatotype dispersion distance (SDD) and somatotype dispersion index were calculated using the formulae given by Ross and Wilson (1973).

One way analysis of variance test was used for comparing the control and the exposed groups for various biological variables.

Results and Discussion

Both exposed males and females have significantly lower FVC, FEV_1, and PEFR than control workers (*Fig. 2*). Mean values of pulse count and blood pressure are significantly greater in exposed than in control groups (*Fig. 3*).

Right and Left hands grip strengths are significantly lower in the exposed female workers than in the controls (*Fig. 4*). In males, though the trend is in the same direction, the differences between the two groups is statistically not significant at 5% probability level.

There are no marked differences between the control and the exposed groups in linear body dimensions such as stature, sitting height, lower extremity length etc., but the exposed subjects are significantly lighter, possess smaller breadths, circumferences and skinfolds than the control group (*Figs. 5, 6, 7, 8*). The mean values of age in the exposed and the control groups are similar in both males and females.

Figure 9 depicts that male stone quarry workers (1.60–1.59–3.54) have significantly lower values in endomorphic and mesomorphic components and higher, but not significantly, ectomorphic component than the controls (2.95–2.57–3.32). Similarly female stone quarry workers (2.00–1.70–2.41) also have significantly lower endomorphic and mesomorphic components and significantly higher ectomorphic component than control females (2.47–3.13–2.00). The exposed females show lower variation in physique, as evident from SDI, than the control females (*Fig. 9*), but the control males and the exposed males do not differ significantly with respect to this trait.

The stone quarry workers, both males and females, are physically less fit as compared to their respective controls (control females = 99.87; exposed females = 67.30 : Control males = 113.49; exposed males = 87.82).

A lot of dust is produced during milling, blasting and grinding in stone quarries. During these processes dust particles of respirable fractions are also produced. When inhaled these particles of respirable fraction can get deposited in the gas exchanging portions and in the conducting airways of the lungs. These depositions decrease the velocity and amount of gas thus limiting the gas exchange (West 1974). Any airway obstruction in the lungs result in lowered lung functions (Cotes 1978). Thus lowered pulmonary test functions in the exposed Malis, both males and females, show impairement of lungs due to stone dust exposure.

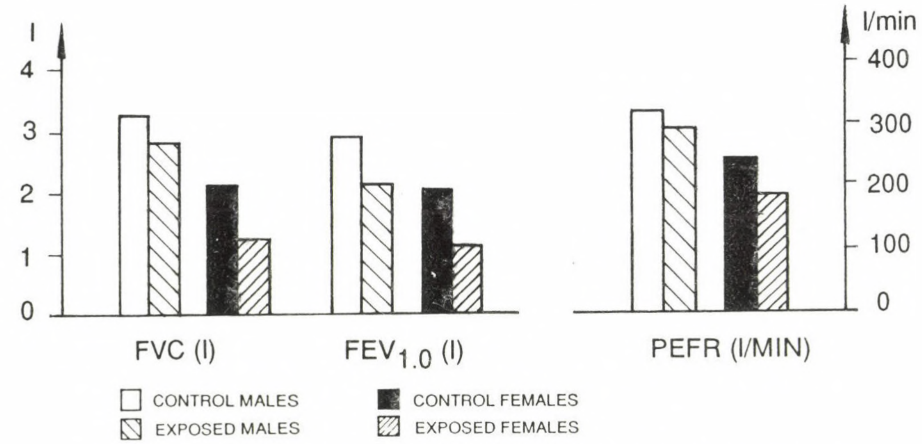

Fig. 2: Impact of stone dust on lung functions: comparison of control and exposed workers

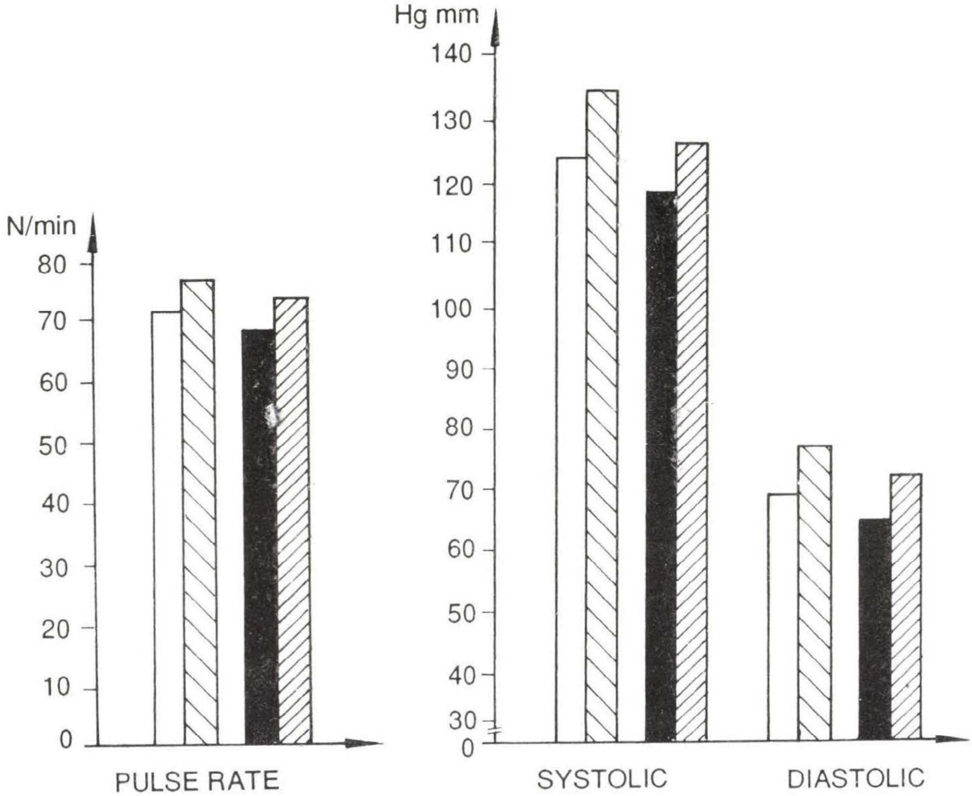

Fig. 3: Impact of stone dust on pulse rate, blood pressure: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

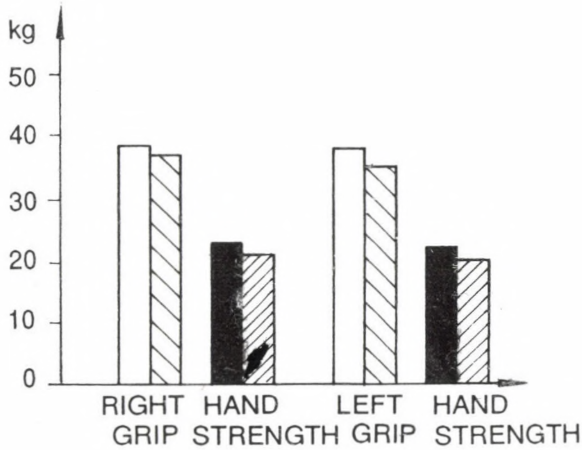

Fig. 4: Impact of stone dust on lung functions: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

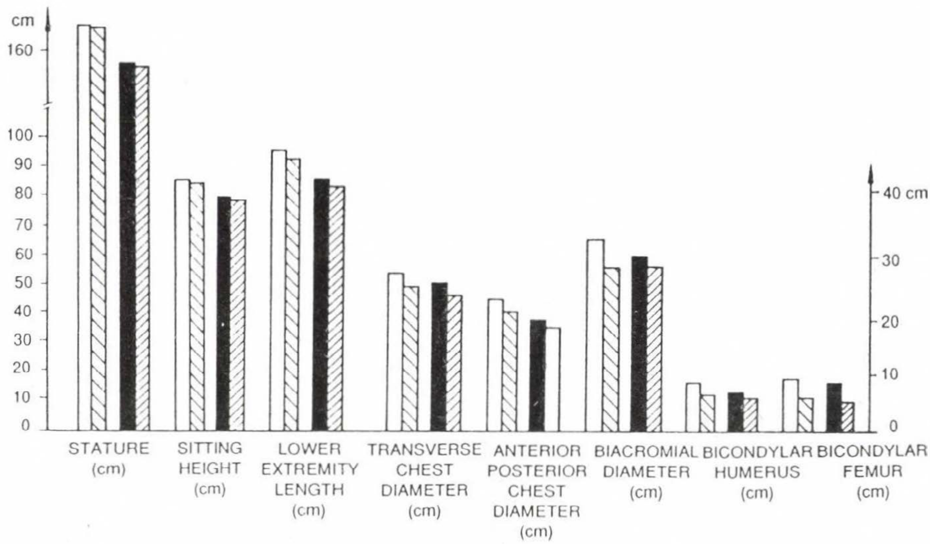

Fig. 5: Impact of stone dust on anthropometric measurements: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

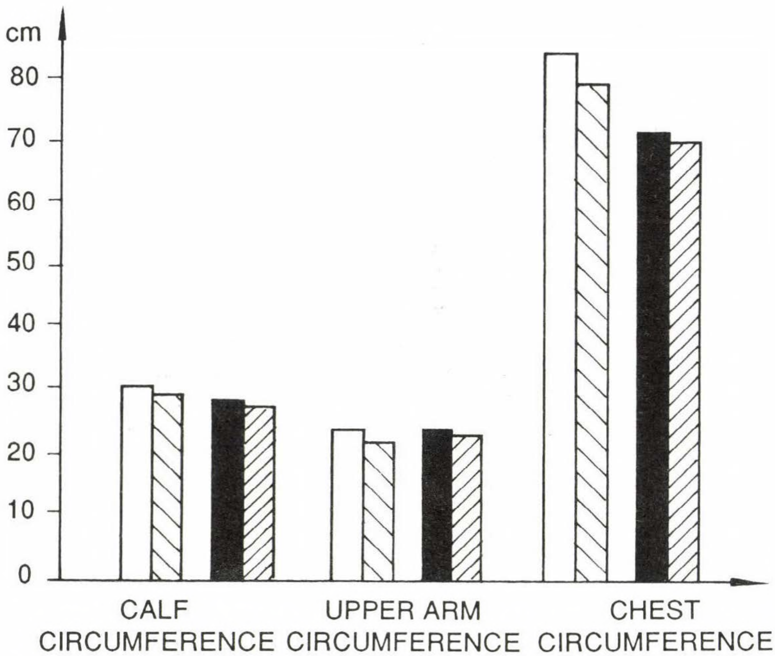

Fig. 6: Impact of stone dust on circumferences: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

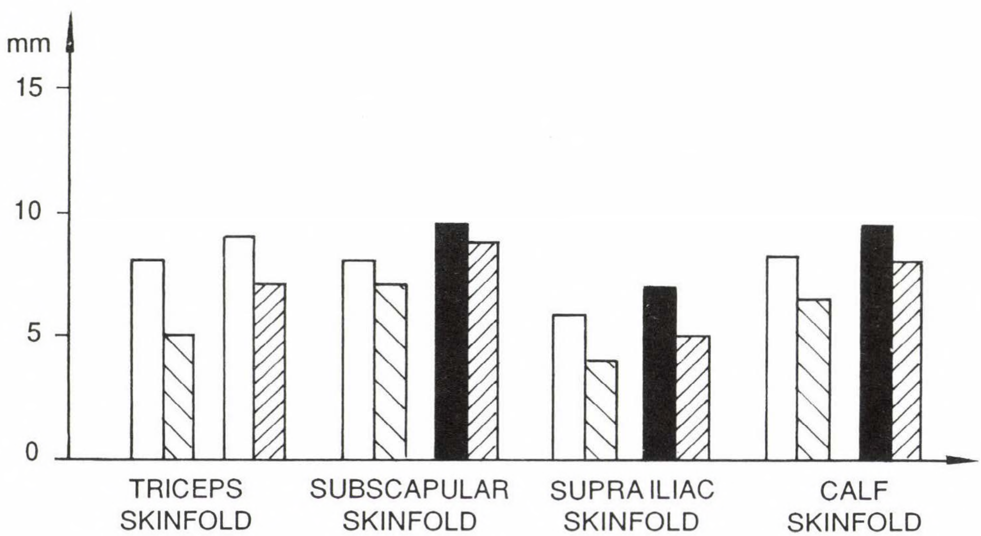

Fig. 7: Impact of stone dust on skinfolds: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

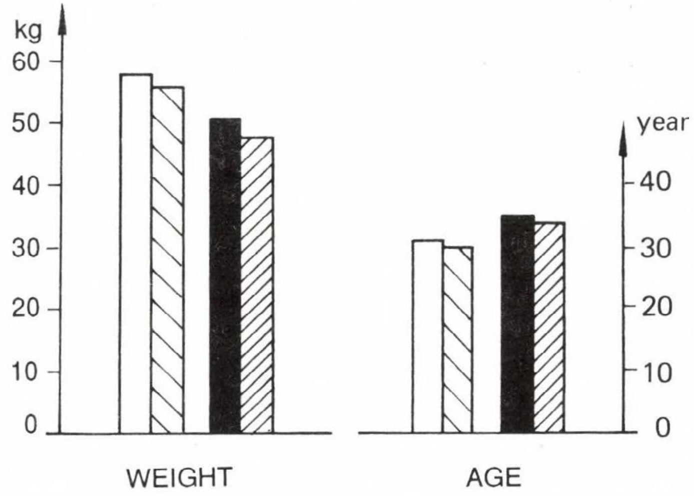

Fig. 8: Impact of stone dust on weight and age: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

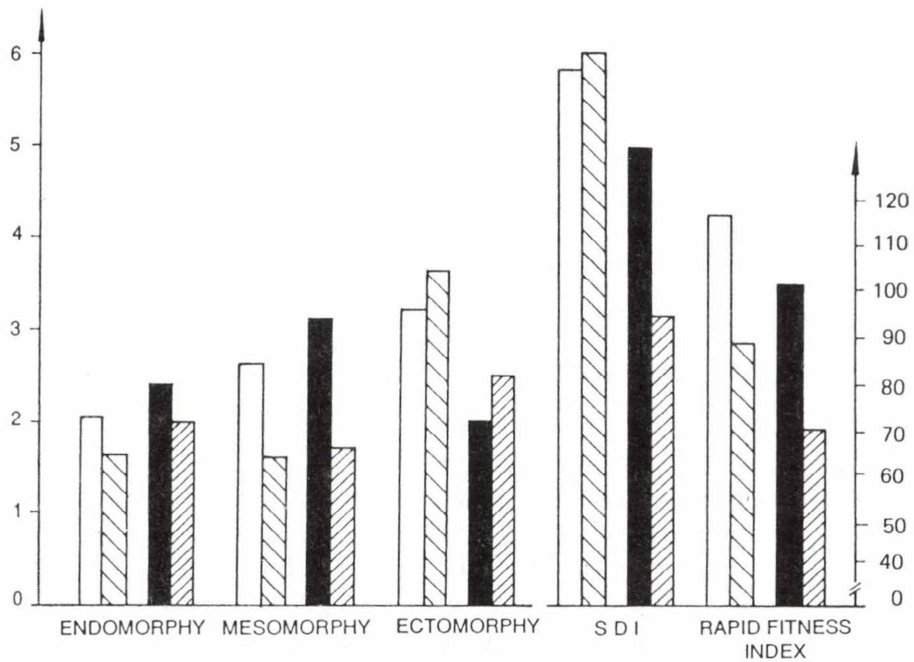

Fig. 9: Impact of stone dust on somatotype and Rapid Fitness Index: comparison of control and exposed workers (for key to the signs of bars used see Fig. 2)

Pulmonary test functions indicate merely the presence of an underlying structural change without describing the nature of structural change (Mauderly 1989). None the less they provide information of the presence, type and extent of impairement, as they are responsive indicators to an inhaled material (Silbaugh et al. 1981).

The stone dust contains substantial amount of silica and is thus capable of causing a lung disorder called silicosis. The biologic effects of inhaled particles depend on their retention at a specific time. Dust particle deposition is not uniform in all the airways. In upper respiratory tract, enhanced deposition occurs in areas characterised by constriction, directional changes and higher air velocities, e.g. larynx, esopharyngeal bend and nasal passages (Shift 1981, Shift and Proctor 1988). In tracheobronchial region increased depositions occur at upper trachea, lobar bronchi and bronchial bifurcations (Schlesinger et al. 1982). In pulmonary region, bronchiolar and alveolar duct bifurcations are also the site of preferential deposition for wide range of particles which are small enough to reach these areas (Broody and Roe 1983, Holma 1969). In these sites of preferential depositions, the mechanism of clearance is also retarded (Hilding 1957). Thus in tracheobronchial and pulmonary regions there are greater chances of particle depositions that can cause airways obstruction and lower the pulmonary test functions. Such an airway obstruction is also the precursos to other pulmonary ailments. It can thus be inferred that the lower pulmonary test functions are mainly due to high level and long duration of dust exposure in Malis.

Earlier studies have reported that certain chemicals, such as lead, cadmium and oral contraceptive steroids increase systematic arterial blood pressure and heart rate as an acute event by a variety of mechanism (Billingham 1980, Merin 1981, Rubin and Rubin 1982, Steffy 1982, Van Stee 1982, Zakari and Aviado 1982). However not much work has been done to study the effect of mineral dust or organic dust on cardiovascular system. In present study the stone quarry workers have significantly higher pulse rate and blood pressure. The cardiovascular stress, on one hand, and lowered pulmonary functions on the other confirm the effect of dust on physiology of man.

Lowered pulmonary test functions and increased respiratory diseases and symptoms in the exposed workers (Malik and Swami 1991) indicate reduction in oxygen diffusion and oxygen supply to tissues in Malis. This restricted oxygen supply, in combination with the loss of appetite and lower food intake, as compared to the pastoral Malis, reduces energy liberation. This may be responsible for the reduced performance and a decrease in mesomorphic and endomorphic components in stone quarry workers. Lower body weight, skinfolds, breadths and circumferences in exposed Malis may also be a consequence of this. Katch and McArdle (1981) had a similar observation that under condition of lower food intake, fat deposition is low.

The physique of Malis having low endomorphy and high ectomorphy, in general, seems to be advantageous for living in the desert climate of Rajasthan, special under limited nutritional resources and heavy work load. Under hot conditions persons with linear physique are able to dissipiate heat more effectively, and they also produce less heat.

In conclusion, stone dust exposure results in lower lung functions, produces adverse effects on cardiovascular system, reduces physical fitness, strength, and decreases body weight, fat, breadths, circumferences and endomorphic and mesomorphic components.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 20 September, 1991.

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Anthrop. Közl. *33;* 203–206. (1991)

AGE DEPENDENCE OF EXERCISE OXYGEN PULSE IN ATHLETIC BOYS AGED 11 TO 15

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Abstract: *Relationships of peak execise oxygen pulse to calendar and morphological age were studied in 203 regularly exercizing active boy athletes (fencing, jodo, kayak and canoe, modern pentathlon, soccer, track and field). The test exercise was of the all-out type. The results were analyzed by linear correlation. Grouped by age, the subjects could be regarded as a selected sample at least in respect of body mass and relative fat content. Their mean body mass was lighter than that of peer-age Budapest boys, proportionately to their lower body fat content. Despite that the respective means of calendar and morphological age were not statistically different in any of the five age groups, peak exercise oxygen pulse correlated with morphological age while was uncorrelated with calendar age at every age.*

Key words: *Athletic boys; Oxygen pulse; Body measurements.*

Introduction

Exercise oxygen pulse is a valid indicator of cardiac performance capacity. Similarly to the physical ones, the physiological indicators of performance depend on age in general. Bar-Or (1983) reported a slow age-dependent decrease of peak exercise heart rate and a parallel moderate increase of oxygen pulse in not regularly athletic children. Demeter (1981) reported a significant but moderate relationship of resting and exercise oxygen pulse with age in a cross-sectional study. He found that an intense training of 6 to 8 weeks for cardio-respiratory endurance failed to bring about an appreciable change in either resting or exercise oxygen pulse.

In general, oxygen pulse at the end of an all-out exercise has been reported to be higher in athletic children and adolescents with a training history of several years (Frenkl 1991, Mészáros 1991) than in peer-age non-athletic youth (Bar-Or 1983). In this respect, the preferred event of sport is of relevance as well. Pekkarinen and associates (1991) found a difference of 2.5 ml . beat^{-1} between the exercise oxygen pulse means of skiers and non-athletes of similar body height and mass at the age of 13!

The authors referred to are all of the opinion that any of the physiological variables measured by volume depend on the size of the body so also on the volumes of the heart and lungs. Frenkl (1990) in his review of the literature gave a summary of physical training effects occurring in children and adolescents. Unfortunately, he failed to mention data on how long it would take to develop significant changes under these effects.

Researchers differ in their opinions on how to calculate relative physiological characteristics so the same indicator has been related to body dimensions of length, volume or even surface (Åstrand and Rodahl 1977, Bar-Or 1983, Kereszty 1967). Since we did not want to take sides in this matter, peak exercise oxygen pulse was related to age as an absolute value in the present study. The purpose was to disclose differences, if any, in the relationship of peak exercise oxygen pulse with calendar and morphological age.

Material and Methods

All of the 203 boy subjects lived in the capital Budapest, had at least one year of training history and 5 to 8 training sessions a week. They were subdivided into age groups by their calendar age. The occurrence of events (fencing, judo, kayak and canoe, modern pentathlon, soccer, track and field) within the age groups was uncontrolled.

Anthropometric dimensions were taken before the exercise tests, observing the recommendations of the IBP (Weiner and Lourie 1969). Morphological age (an equivalent of biological age validated by bone age, Mészáros et al. 1984, 1985) was estimated by using five body dimensions and calendar age. Relative body fat was estimated by skinfolds (using a regression formula based on Pařízková's technique, 1961).

The all-out exercise tests were carried out on a Jaeger treadmill. Exygen pulse values were obtained by dividing continuously monitored oxygen uptake and heart rate values.

Both calendar and morphological age were expressed in decimal years and correlated with peak exercise oxygen pulse values in every age group. Linear coefficients were compared after *z*-transformation. Differences between age-group means were tested by one-sample *t*-tests at the 5% level of random error.

Results and Discussion

Table 1 contains the means, sd's and case numbers for the respective variables and age groups.

Table 1. **The studied variables (mean ± sd)**

Age	11	12	13	14	15
DA	11.1 ± 0.3	12.0 ± 0.3	12.9 ± 0.3	13.6 ± 0.2	14.9 ± 0.3
MA	10.7 ± 0.6	11.9 ± 0.7	12.9 ± 0.7	13.9 ± 0.6	15.0 ± 0.5
BH	144.4 ± 6.4	149.5 ± 6.8	156.5 ± 6.6	164.9 ± 6.7	171.1 ± 7.0
BM	34.1 ± 5.6	39.6 ± 7.3	44.7 ± 6.8	52.3 ± 7.5	58.4 ± 7.5
F%	12.3 ± 4.2	14.8 ± 4.3	14.5 ± 3.6	14.7 ± 3.1	13.1 ± 3.8
O_2P	9.3 ± 1.6	11.0 ± 2.1	13.0 ± 3.0	14.1 ± 2.3	16.3 ± 2.1
n	49	44	26	33	51

Abbr.: DA = calendar age in decimal years; MA = morphological age in decimal years; BH = body height in cm; O_2P = oxygen pulse in ml .beat^{-1}; n = case numbers.
Note: Age groups were formed around nominal years to range from .51 of previous to .50 of current.

The means of calendar and morphological ages were statistically equal consistently in every age group. This finding was regarded as favourable since exercise parameters of children with considerable acceleration or retardation had often been misinterpreted (cf. Mészáros et al. 1987). Stature in the age groups of 11 through 13 was very close to the Budapest reference values while those aged 14 and 15 were slightly taller than their non-athletic peers (Mohácsi and Mészáros 1987). This finding is attributable, in our opinion, to differences in the event occurrence within the age groups.

Body mass means were smaller than the Budapest reference values in all the five age groups. This smaller body mass is related to the 12 to 15% content of body fat characteristic of our sample.

The means of peak exercise oxygen pulse increased with age almost linearly. The observed values exceeded those reported for non-athletes in every age group (Bar-Or 1983, Demeter 1981), but were slightly below those reported for age groups engaged in endurance sports and homogenous in respect of preferred event (Frenkl et al. 1991, Pekkarinen et al. 1991). This finding has been regarded as arising from a specificity of the respective sport events rather than being attributable to a diversity in athletic preparation. Cardio-respiratory training stress is much higher in modern pentathlon, paddling, skiing or track-and-field athletics than e.g. in ball games or fencing.

Table 2 summarizes the coefficients between peak exercise oxygen pulse and calendar, respectively morphological age as well as those between the two kinds of ages.

Table 2. **Some coefficients of the correlation analysis**

Age-Group	DA & MA	MA & O_2P	DA & O_2P	$r_{0.05}$
11 yr	.33	.53	.08	.28
12 yr	.36	.76	.03	.30
13 yr	.26	.76	.25	.38
14 yr	.26	.64	.32	.34
15 yr	.27	.48	.10	.27

Abbreviations as in Table 1; $r_{0.05}$: significance limit

Relationship of peak exercise oxygen pulse with chronological age was found to be statistically not different from zero in all the age groups. In contrast, it was significantly correlated with morphological age throughout the studied ages. Close correlation was found for ages between 12 and 14 while a loose to moderate one for ages 11 and 15.

The finding that our athletic boys had higher peak exercise oxygen pulse values than the non-athletic peers has been considered an effect of regular physical training. As our matgerial contained very young subjects as well, this effect was attributed primarily to adaptive changes in the control mechanism of the heart rate and secondarily or to a smaller extent (particularly in the groups aged 13 to 15) to a larger stroke volume due to exercise-induced myocardial hypertrophy.

Correlation analysis results have again drawn attention to the necessity of assessing biologically based age, in particular when some or other motor performance has to be evaluated. In this respect, differences between coefficients are thought to reflect the characteristic properties of adolescence. The intense growth of the body and the internal organs between ages 12 and 14 may be an important contributor to better performance. On the other hand, the almost linear increase of peak exercise oxygen pulse is a definite result of physical training. Frenkl (1990) and Falkner and Tanner (1978) agree in stating that in regularly exercizing youth the amplitude of "oscillations" in the age dependence of functional parameters is much smaller while the rate of development is much faster.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 11 October, 1991.

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Anthrop. Közl. *33*; 207–211. (1991)

GROWTH TYPE AND EXERCISE CHANGES IN SKIN TEMPERATURE IN ATHLETIC BOYS

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Abstract: *A group of 51 regularly exercizing athletic boys of 15 years was subdivided into moderately leptomorphic and moderately pyknomorphic subjects by Conrad's metric index (1963). The anthropometric properties (morphological age, body mass and height, relative fat content and Conrad's plastic index) did not differ statistically between the two subgroups except of stature that was taller in the more leptomorphic subgroup. The analysis of skin temperature changes recorded during a graded all-out ergometric treadmill exercise revealed that the more linear subjects had a higher skin temperature during the exercise. Most of the exercise physiology parameters were comparable in the two groups, but maximum stroke volume was significantly greater in the moderately pyknomorphic group.*

Key words: *Growth type; Skin temperature; Athletic boy.*

Introduction

Efficiency of thermoregulation during continuous physical exercise has been a point early recognized and studied in exercise physiology. Nielsen (1938) stated already 50 years ago that changes in body temperature during steady-state exercise were essentially independent from ambient temperature between 5 and 30 °C and were mainly related to the intensity of metabolic processes. Using a more modern technique for measuring the variously weighted components of the thermoregulatory mechanism, Saltin and Hermansen (1966) confirmed Nielsen's results. Gisolfi (1983) reported that thermoregulatory mechanisms work actually in a similar way both at rest and during exercise. In our opinion, this is merely a relative similarity since only the integrated output of the thermoregulatory "input mechanisms" (hydration status, increase of the temperature and osmolality of the internal milieu, sweating intensity, changes in skin blood flow, etc.) can be measured. Gisolfi (1983) and Stolvijk and Nadel (1973) thought that during exercise a new plateau (new reference level) of internal temperature would develop and this could be modified by the regulatory systems at each grade of exercise when necessary.

Bar-Or (1983) and Araki et al. (1979) have drawn attention to the fact that the development of the new reference level depends on age as well. In young subjects the same intensity of exercise would bring about faster changes, the level of internal temperature that would force one to stop exercizing could develop earlier. As Drinkwater and Horvath (1979) found, the rate of heat exchange between the body and skin of young subjects is lower than in adults, accordingly, the heat stress of a warm environment or repetitive exercise is greater for them. Functional relationships of the regulatory mechanisms (thus of thermoregulation, too) with body build have hardly been investigated till now.

A group of 51 of athletically regularly active boys of age 15 was subdivided into more and less leptomorphic groups by using the metric index of Conrad's growth type. This index describes the linearity of the body so the less leptomorphic subgroup was taken as having an "athletic build". The purpose of the study was to compare the exercise physiological parameters and thermoregulatory patterns (as reflected by changes in chest skin temperature) of the subgroups.

Material and Methods

The subjects were male modern pentathlonists and triathlonists, paddlers (kayak and canoe) and track-and-field athletes. They had a sports history of 4 years and 5 to 9 training sessions a week.

Anthropometry was taken before the exercise test. Morphological age (Mészáros et al. 1985), the metric and plastic indices of the growth type (Conrad 1963) and weight-related body fat by skinfolds (by using a regression formula based on Parízková's 1961 suggestions) were calculated.

The all-out graded exercise test was carried out by using Jaeger model analysers and treadmill. Starting on the level, the incline of the 12 kmh belt was increased by 3 degrees every second min until exhaustion.

Changes in the skin temperature of the chest (recording point corresponding to the V6 lead of the ecg) were measured by a YSI–709 transducer connected via an impedance bridge amplifier to a computer. Readings were accurate to the nearest 0.01 °C, mean response time was 1 s.

Exercise changes in the physiological parameters and skin temperature were analyzed at the relative timespoints of 0, 25, 50, 75 and 100% of net running time.

The obtained means of the subgroups were tested for differences by t-tests for dependent and independent samples at the 5% level of random error.

Results and Discussion

Table 1 contains the means, sd's, case numbers and two-sample t-values for the observed variables in the groups. No significant differences were found between the calendar and morphological age means either within or between the groups. Anyone classified as more leptomorphic would not necessarily be tall as this property refers to the relationship of chest dimensions to height. Yet, the more leptomorphic group was found to be significantly taller than the more pyknomorphic group or the mean of non-athletic peers reported by Mohácsi and Mészáros (1987). Mean body mass was statistically equal in the two groups, this also meaning that the athletic-build group had a larger height-related mass. This finding was explained by a larger muscle mass in the latter group since there was no difference in their relative fat content. As the measure of body linearity or gracility, the metric index of the growth type, was used as a classifying criterion, the significant difference in that was obvious. Statistical equivalence of the respective plastic index means should not mislead one to assume an equal developmental grade of the skeleto-muscular system: The athletic-build subgroup was more robust, because they were smaller.

Table 1. **Anthropometric variables (mean ± sd)**

Var	Leptomorphic (n = 17)	t	Athletic-build (n = 34)
DA	14.88 ± 0.27	NS	14.88 ± 0.26
MA	14.92 ± 0.47	NS	14.94 ± 0.54
BH	173.42 ± 7.81	2.15	168.58 ± 6.59
BM	55.17 ± 7.25	NS	58.23 ± 9.09
F%	13.04 ± 3.78	NS	13.68 ± 4.65
MIX	−1.53 ± 0.22	6.79	−0.99 ± 0.27
PLX	82.46 ± 2.77	NS	83.56 ± 4.44

Abbr.: DA = calendar age in decimal yrs; MA = morphological age in decimal yrs; BH = body height in cm; BM = body mass in kg; F% = weight-related body fat percentage; MIX = metric index in cm; PLX = plastic index in cm; NS = not significant

Table 2 summarizes the means, sd's asnd *t*-tests of skin temperatures, weight-related oxygen uptakes und the oxygen pulse values. The latter are expressions of myocardial performance capacity.

Table 2. **Exercise physiological variables (mean ± sd)**

Groups according to NRT%	Leptomorphic (n = 17)	t	Athletic-build (n = 34)
Skin temperature °C			
0	33.51 ± 1.22	2.96	32.52 ± 1.08
25	33.59 ± 1.06	3.25	32.56 ± 1.07
50	33.79 ± 1.14	3.56	32.64 ± 1.06
75	34.08 ± 1.14	4.02	32.76 ± 1.09
100	34.12 ± 1.25	3.90	32.80 ± 1.09
Relative oxygen uptake ml .min^{-1} .kg^{-1}			
0	36.09 ± 4.17	NS	36.63 ± 4.35
25	43.79 ± 4.54	NS	45.09 ± 4.73
50	48.41 ± 4.81	NS	49.62 ± 4.93
75	52.09 ± 4.05	NS	54.52 ± 4.37
100	55.53 ± 4.65	2.03	58.57 ± 4.08
Oxygen pulse ml .beat^{-1}			
0	11.51 ± 2.45	NS	12.00 ± 3.05
25	13.88 ± 2.03	NS	14.81 ± 1.60
50	14.48 ± 2.92	NS	15.48 ± 2.07
75	15.16 ± 1.94	2.59	16.73 ± 2.09
100	15.73 ± 2.37	2.61	17.81 ± 2.82

Abbr.: NRT% = relative exercise intensity expressed as percentage of net running time

The direction of change in skin temperature during exercise was similar in the two groups. However, skin temperature in the more leptomorphic groups was higher already at the outset and by 0.33 °C higher by the end of the exercise. Relative oxygen uptakes did not differ between the 0 and 75% points of running, but at the 100% point the athletic-build group had a 3 ml higher relative aerobic capacity. Peak exercise oxygen uptake was higher in both groups than that reported for non-athletes (Bar-Or 1983, Demeter 1981).

Means for the oxygen pulse became statistically higher in the more pyknomorphic group already from the 75% point.

The conclusion arrived at by analyzing the results was that the relationship between quantitative measures of thermoregulation and body build was not due to chance. Delamarche et al. (1990) reported a parallel change of core and skin temperatures. This would imply for our study that the more leptomorphic group produced more heat during exercise. The same authors also stated that sweat production became more intense around a core temperature of 38 °C. This finding might explain the large interindividual differences in the timing of intense sweating.

When this side of the problem is approached from another aspect, a rather interesting point emerges. The group described as having an athletic body build displayed a larger relative body mass and motor system development, thus also the relative fraction of muscle mass could be thought of as being larger. This larger muscle mass should, however, have produced more heat during exercise rather than less.

Larger relative aerobic power and higher oxygen pulse are indirectly also related with one another and with body build as well. As shown by reports on X-ray and echographic studies, the shape of the heart is individually different. Left ventricular shape, consequently also size is important not only for oxygen uptake: Circulation has the additional duty of transferring heat from the inside of the body to the skin. This requires a not negligible fraction of cardiac output. The relationship between skin circulation and sweat production is well established (Bar-Or 1983, Araki et al. 1979) and, as known, the extent of sweating is rather variable from individual to individual.

We consider the obtained results have mainly an informative value because of the small number of cases and narrow age range. Anyway, already a partially developed adaptation to exercise and constitutional build, as in our sample, seem to be of importance in thermoregulation during exercise. The differences termed input factors by Gisolfi (1983) as well as central effects (so e.g. the sensitivity of the hypothalamic thermal centre) may also have a role in the observed dissimilar ways of function.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991;
Received 11 October, 1991.

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Anthrop. Közl. *33;* 213–220. (1991)

GROWTH AND GENETICS

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Abstract: *From the many studies of growth from different view points, a series of principles can be derived summarising the genetic control of growth. These principles are illustrated in relation to fetal and postnatal growth. Genetic control is seen to be complex, operating throughout the whole growth period; genetic effects are tissue specifie and time specific; there are many genes involved, and many are pleiotropic.*

Key words: *Genetic defects; Growth factors; Switch mechanisms; Birth weight; Pleiotropism.*

Introduction: Growth and Genetics

What do we know of the genetic control of growth now that we did not know at mid-century? Almost all of our knowledge of growth, apart from the earlier descriptive studies, derives from this period, – recognition of the importance of longitudinal studies, the translation of measurements at given ages into velocities, the analysis of individual growth curves into the component segments, the explanation of differences in the growth curves between populations in terms of differences in these velocities, and the identification of the factors that affect them. So too almost all of our knowledge of the genetics of growth, slight though it is, derives from this period and the last few years especially.

Investigation of the genetic control of human growth and development is not straightforward. Growth in the fetal and postnatal phases is essentially a continuum, yet each phase presents characteristic difficulties. In the prenatal period classic methods of genetic analysis, examining patterns of variation within families and comparing relatives of different degrees, cannot be applied. There are virtually no data relating to more than one member of a sibship, except for the culmination of fetal growth, the weight of the infant at birth. Of noninterventive techniques, radiography did little more than trace growth in size (Russell 1969); more recently, ultrasonic scanning holds great promise, as it allows serial examinations from which can be collected data on growth of the body and its parts, and on the onset of specific functions, which can be used for analysis of familial correlations. With amniocentesis there is opportunity to accumulate data on biochemical variants. Yet so far most genetic knowledge of the prenatal phase of growth has only been obtained indirectly. As regards portnatal growth, it is easier to obtain information on sibs and other pairs of relatives of like age, yet from the duration of the human growth process there will be very few investigators who can trace development over a period in family members of more than one generation, though there are a few very farsighted studies where this is being done.

Single genes affecting normal growth

The Mendelian Template

One approach to identify specific genes acting both pre- and postnatally is that of the *Mendelian template* (Roberts 1981). A considerable amount about normal growth can be inferred from the genetic defects that occur. At the locus for every gene that produces an established pathological entity, there must also be a normal allele controlling normal growth. The well-established dominant condition, classical achondroplasia, is characterised by shortening of the long bones, particularly their proximal segments, wide shallow pelvic inlet, poorly developed iliac wings, narrowed sacrum and sciatic notch, short ribs, and other skeletal abnormalities. These many skeletal malformations all derive from a single functional defect, a quantitative defect in the endochondral ossification. The histology is normal, with regular columns of cells with normal matrix; it is the rate that is at fault. Therefore there must be at the achondroplasia locus a normal allele which is involved in the control of the rate of endochondral ossification.

In severe rhizomelic chondrodysplasia punctata, an autosomal recessive condition, the limbs are also strikingly short at birth, there is metaphyseal cupping, splaying and abnormal ossification especially of the femur and humerus, and there occur associated defects of the heart, skin, palatal and mental development. Here the mechanism of the bone defect is different, for it is the endochondral bone formation that is grossly abnormal as shown histologically in the deficient columnar arrangement, with slight calcification of the matrix. Therefore there must be at the same locus a normal allele controlling, or involved in, the endochondral ossification, but this time not quantitatively but qualitatively. The same allele may also have pleiotropic effects, being involved in normal heart and skin development. In chondro-ectodermal dysplasia (the Ellis van Creveld syndrome) another autosomal recessive, the distal limb long bones are shortened and indeed the distal phalanges are very hypoplastic, the radius is broadened distally and often dislocated proximally, and the proximal tibial shaft is flared. Here the error occurs in the control of differentiation as well as organisation, for often the capitate and hamate bones, and sometimes the other carpal bones, are fused, and there may be ulnar polydactyly. Histologically the cell columns, though generally parallel in arrangement, are disordered, shortened, and fewer than normal. There must therefore be a normal allele directing the differentiation of the normal centres. But it must also control formation of hair and tooth buds, for hypotrichosis and hypodontia are characteristic of the condition.

In Crouzon's craniofacial dysostosis, a dominant condition, with its characteristic frontal bossing, flat face, hypertelorism, small maxilla but normal lower jaw, the defects are due to a shortening of the anterior part of the base of the skull and early closure of the coronal, sagittal and lambdoid sutures. There must therefore be a normal allele controlling growth in this restricted part of the skeleton. Such a template approach shows the complexity of genetic factors in fetal growth, the interaction of quantitative and qualitative control, the large number of genes involved, and particularly the pleiotropic effects of many of them. But this approach is gross, and more detailed information comes from other sources.

Physiological

Another approach is the *physiological cum genetic*. There is no doubt that systemic effects are extremely important in coordinating overall body growth during fetal and postnatal periods and though these operate at the gross level these too are under genetic control. Several genes are known.

a) *Growth hormone* (GH), produced by the anterior pituitary is critical, for overproduction produces gigantism and underproduction dwarfism. Growth hormone is controlled by a gene whose existence and effects can be demonstrated by the use of transgenic experimental animals (Palmiter et al. 1983). The hormone can be produced artificially and applied to ameliorate disorders of growth in children The genes for growth hormone are located at chromosome 17q22–24, and that for its receptor (GHR) at 5p13–12. But growth hormone production and release are stimulated by the growth hormone releasing hormone (GHRH), and the gene for this is located at 20p11.23.

b) There are the insulin like growth factors, the *somatomedins,* peptides that are growth hormone-dependent that promote cellular proliferation (Hintz 1980). In man there are at least two distinct somatomedin peptides. Human insulin-like growth factor I (IGF I) is an important mediator of balanced growth of most tissues of the body, the molecular structure has been established, and the genes have been sequenced. The gene for IGF I is situated at chromosome 12q23, and that for the receptor for this factor on chromosome 15. The gene for IGF II is situated at chromosome 11p15.5, and its receptor on chromosome 6q. But IGF I production is regulated also by dietary intake and nutritional status, apparently through alterations of the GH receptors and of post receptor responsiveness to GH.

c) Then there is the *platelet derived growth factor* (PDGF); its polypeptide chains are under separate genetic control. The alpha polypeptide is situated on chromosome 7, and the beta polypeptide on chromosome 22. As for the genes for the receptors, those of the alpha polypeptide are situated at chromosome 4q11–13 and for beta polypeptide at 5q33–35. PDGF is a potent mitogen for cells of connective tissue origin and plays a central role in controlling glial cell differentiation and division (Ross et al. 1986).

d) The *transforming growth factor* is now known to be heterogeneous. Transforming growth factor alpha is situated at chromosome 2p13, while transforming growth factor beta has several subdivisions, beta 1 being situated at chromosome 19q13.1 and beta 3 at chromosome 14q24. Perhaps the multiple functions formerly associated with this factor are subsumed by its different components. TGF beta stimulates or inhibits cell division, and positively or negatively controls cell differentiation; e.g. it induces chondrogenesis and squamous differentiation of bronchial epithelium but blocks myogenesis and adipogenesis.

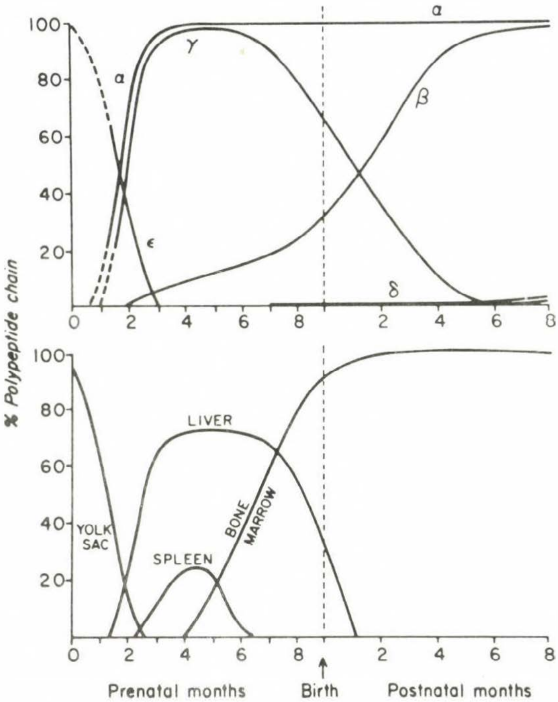

Fig. 1: Ontogeny of human hemoglobin chains and sites of blood formation at different stages of development. Note this close similarity in the time sequences of yolk sac and ε-chain, hepatosplenic and γ-chain, and bone marrow and β-chain erythropoiesis

Growth factors are so called because of their mitogenic effects, and with the availability of nucleotide sequence data many molecules that affect cell differentiation, induction, pattern formation, and that stimulate and inhibit cell division, are seen to cluster together into closely related growth factor families. The list of growth factors which have different effects during development is growing rapidly. The view that the division of a cell type and its effect on the growth of a particular tissue during development is under the control of a single, unique, locally produced growth factor is no longer tenable. The evidence is increasing that single growth factors have diverse functions, that embryonic cells respond to particular growth factors in different waqys, and that cells from the same region of the embryo may respond to the same growth factor differently at different times.

Genetic mechanisms

The genetic information controlling growth, as all other body characters, is the DNA transmitted on the parental chromosomes to the new organism at the moment of conception. Meticulously reproduced in subsequent cell divisions, it controls the structures of all the proteins making up and made by the new organism, regulates their synthesis and their interaction with other substances, to give the biochemical make up of each individual. The sequence of developmental differentiation, and individual variations in it, are consequences of differences in enzyme or protein synthesis. The gene-controlled synthetic processes take place in the environment provided by the cell cytoplasm, where it is subject to other influences besides the genes.

Further instructions come from the highly organised cascade and cyclical chemical reaction systems, in which the product of one reaction forms the substrate of the next. The miracle of differentiation from the fertilised ovum of different kinds of cells, tissues and organs is brought about through a sequence of changing populations of cells organised in increasingly complex patterns. The delicacy of the process of cell division ensures that daughter cells contain virtually identical sets of genes. As division succeeds division, divergence of cells occurs until they have differentiated into types quite different in appearance and function e.g. muscle, pigment or nerve. These different cells behave almost as though they had been given different sets of genes, but this is clearly not so. It is not the genes or the chromosomes that are distributed unequally, instead the cell must be manifesting the effects of only a small fraction of its genes, in the differing chemical environments that have developed. The genetic potentialities of the cells are far greater than the actualities that they express.

The genetic control of embryonic and fetal development occurs as a result of (1) switch mechanisms, switching on and off the activity of particular genes, at (2) specific times in development, and producing (3) specific substances. Variations in fetal growth and development therefore may arise by (1) variation in efficiency or failure of the switch mechanism, (2) variation in its timing and (3) variation or errors in the substances synthesised. There is every reason to believe that similar control exists postnatally, with the switch being responsive to feedback from the body itself in response also to environmental stimulation. This model can be validated by examination of the variant substances or deficiency of substances, in association with fetal developmental stages (Roberts 1986). Such studies show

1. There is tissue specificity of isoenzymes;
2. There is subcellular localisation;
3. There is temporal variation in isoenzymes, both quantitative and qualitative;
4. The tissue changes are asynchronous.

But there are other mechanisms that bring about selective expression of gene products, in addition to sequential activation by switching. In the normal process by which a cell acts on genetic instructions there are a number of points of control. There may be gene amplification by differential replication, giving multiple copies so that the number of RNA molecules produced per unit time is increased. There may be different rates of transcription, giving altered rates of synthesis of RNA. There may be changes in the rate of passage of the RNA from the nucleus to the cytoplasm. The messenger RNA once synthesised may function a number of times before being degraded, and so enhance the synthetic activity of the cell. There may be regulation of the activity of the DNA in the cytoplasm, to change the rates of protein synthesis. There may be differences in the rate of degradation of some enzymes. The messenger RNA may be stored in an inactive form, accumulating in preparation for periods when bursts of activity are required. Hormones of fetal origin become differentially available during prenatal life, stimulation of mRNA synthesis therefore varies, and since they are all organ-specific they may be a factor in the variation in isoenzyme activity that occurs between organs in fetal life.

Finally there may be epigenetic modification of structure after polypeptide chain pı ›duction.

This discussion has been essentially in terms of biochemical studies and mainly with reference to fetal growth. Another extremely important and informative area of research has been the analysis of quantitative characters, and apart from birth weight, has concerned postnatal growth.

Birth Weight

Birth weight, which represents the culmination of fetal growth and the beginning of the postnatal phase, is the only measure of fetal growth in size where attempts at genetic analysis have been made. Yet it is an artifical entity, for it represents what amounts to an arbitrary point in a continuum, since babies are born at different gestational ages and at different stagees of maturation, so that individuals being compared are not in fact comparable in many respects. The existence of genetic influence is shown by the fact that birth weight of some babies is grossly affected by genetic disease, both single gene and chromosomal – fibrocystic disease, galactosaemia, the Bloom syndrome, Down syndrome, the Turner syndrome and many others. The earlier genetic studies of "normal" birth weight may or may not have excluded such extreme abnormalities, but certainly could not have excluded the less obvious.

Birth weight is a biometric character, so the methods of quantitative genetic analysis can be employed, based on the fact that relatives of different degrees have different proportions of their genes in common. Thus whereas third degree relatives of babies of high or low birth weight are very similar in mean birth weight to the general population, second degree relatives deviate slightly towards the level in the propositi, and first degree relatives do so conspicuously (Ounsted 1968). This is a usesful first step in suggesting some genetic effect in high and low birth weight. The classic study partitioning birth weight variance into its components was that of Penrose (1954). He showed that the contribution of the fetus' own genes in determining its size when it is born is small, and the contribution of maternal factors – both environmental and genetic – is overwhelming. This predominance of maternal factors presumably is a selective effect allowing small mothers to survive the birth of infants from large fathers. Then after birth such strong prenatal influences upon growth are gradually neutralised, the individual's own genes begin to reassert their influence, and postnatal growth moves firmly in a direction determined genotypically, and the individual is back on genetic target by the age of 2–3 years. A child may depart from its genetic channel of growth as a result of extraneous influences or disease, or can be brought back to or near it by appropriate treatment.

Postnatal growth

Quantitative studies provide the principal evidence on genetic control of postnatal growth (Roberts 1981):

1. *Genetic control* operates throughout the whole process of growth

a) Genetic syndromes affect postnatal growth

b) There are positive correlations between relatives at the age at which they reach peak velocity of growth in height, and in attained height. Inbreeding effects on height, sitting height, arm and hand length and other measurements show the directional dominance compatible with the genetic influence demonstrated by familial correlations.

c) Data on the rate of skeletal maturation (appearance of ossification centres) show familial correlations. There are race differences in ossification timing, even allowing for environmental factors.

d) Rate of physiological maturation as assessed by menarcheal age shows fairly high positive correlations, and the heritability of menarcheal age has been estimated at 72–98%.

e) The pattern of development of the different tissues shows family similarity, not only where the more rapid skeletal maturation occurs in the earlier or later years of infancy, but also in the shapes of the velocity curves of maturation.

f) Dental development shows strong genetic control, with high heritabilities of tooth formation time, ages at eruption of particular teeth, and the order in which they calcify. racial differences provide further evidencve.

It seems likely, that for given environmental circumstances, the genetic control of growth processes extends down to many of the details of the velocity and acceleration curves, but few family studies using the neessary curve fitting to individual records have yet been reported.

2. The *genes are independent.* The genes controlling the rate of growth are partly independent of those controlling final size, and the genes controlling postnatal growth exert relatively slight effect on the size attained at birth. Here the evidence consists of the steady increase in the correlation coefficients between child and parent with the age of child.

3. *Developmental polymorphisms.* Though genetic control over most aspects of normal growth, with very few exceptions, is multifactorial stricter for some growth features than for others, a line of evidence is accumulating from longitudinal records of children's growth that polymorphisms (i.e. single loci), are important in development. These polymorphisms refer to:

a) The sequence in which the developmental milestones occur.

b) The sequence of onset of ossification centres in the hand and wrist.

c) The sequence of eruption of the mandibular second premolar and second molar.

d) The HLA system, for diabetic children with HLA B8 appear to grow more slowly than patients without.

4.The genes controlling postnatal growth are widely distributed over the human chromosomes. This is illustrated from the many chromosomal aberrations that are now known, and from the productive current work on gene localisation.

Summary

From the many studies of growth from different view points, a series of principles can be derived summarising the genetic control of growth. For fetal growth, knowledge is obtained indirectly and shows the complexity of genetic control.

1. There are many genes involved;
2. Many of these are pleiotropic;
3. There is interaction of quantitative and qualitative control;
4. Switch mechanisms, activating and inactivating a succession of genes, is the principal mechanism of genetic control;
5. Genetic effects are tissue specific;
6. Genetic effects are time specific;
7. Temporal variations do not coincide in all tissues;
8. Intracellular mechanisms also modify the implementation of genetic instructions.

For postnatal growth there is more direct evidence deriving from quantitative analyses in family studies and indirect evidence from population comparisons.

1. Genetic control operates throughout the whole process of postnatal growth, but is stricter for some features than for others.
2. It is largely multifactorial, though there are some single locus effects.
3. Genes controlling rates of growth are independent of those controlling final size.
4. Different groups of genes operate at different times during growth.
5. Genes controlling growth are widely distributed across the chromosomal array.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. 33; 221–228. (1991)

SOMATIC, MOTOR AND COGNITIVE CHARACTERISTICS OF ITALIAN SCHOOLCHILDREN

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Abstract: *Preliminary results from an ongoing study on associations between somatic, motor and cognitive characteristics in 316 Italian schoolchildren of both sexes aged seven to twelve years are presented. Verbal knowledge of the body was tested, height and weight was measured and psychomotor status was assessed by age specific tasks. The sample was divided according to the region of birth and comparison was made between the children of the South and those of the North and Center combined. A different growth rate is indicated between females only in the two parts of Italy, but both sexes show consistently less verbal knowledge of the body in the South and also less psychomotor achievement. However no significant differences in knowledge of names of body parts with weight for age and for height were verified but there is some indication for better results in psychomotor achievement with lighter weight for age and for height.*

Key words: *Italian schoolchildren; Body dimensions; Psychomotor status; Cognitive knowledge.*

Introduction

The development of a "body scheme", the state of which is assessed by tests of the verbal knowledge of parts of the body (Berges & Lezine 1978) is a functional prerequisite for the development of psychomotor capacities (Vayer 1974). Positive correlation between performance on motor tests and physical development has been confirmed for preschool children (Welon & Sekita 1975), schoolchildren and adolescents (Malina 1984). It is the aim of this preliminary study to enquire if there exist associations between somatic, motor and cognitive characteristics in Italian schoolchildren which are reflected by measures of body dimension, dynamic coordination and cognitive knowledge investigated and to what degree such are influenced by age, sex and place of origin.

Matrials and Methods

In an ongoing study 316 Italian elementary schoolchildren aged seven to twelve years from all parts of Italy were tested in summer camps for verbal knowledge of the body (Berges & Lezine 1978). This test includes 29 questions and to answer them the child points to various parts of his body as for example his cheek, eye-lashes, elbow, heel, hip, etc. The correct responses were pooled into four different groups according to increasing knowledge (A = 18–23, B = 24–25, C = 26–27, D = 28–29). In addition height and weight was measured and psychomotor status was assessed by age specific tasks (one test for each year from six years to eleven years) according to Ozjerezki Guilman (in Vayer 1974). These tests increase in difficulty from the simple task for six years old: walk two meters with open eyes in a straight line putting heel to toe, to the most complicated one for eleven years old: jump flinging your legs backwards and at the same time touch your heels with your hands. For positive performance one out of three tries has to be successful. If the child performs well with its age-specific test, that for the subsequent age is tried, if it fails that for the preceding age is tried.

The sample was divided according to the region of birth and comparison was made between the children of the South and those of the North and Center combined. Slightly varying numbers of individuals in some compilations result from the fact that some individuals could not be investigated for all tasks.

Results and Discussion

Body height and weight

Anthropological studies carried out in Italy in the sixties and in the seventies showed a marked difference in body height between North and Center and the South of Italy (De Toni 1968, Muzzolon 1979), and that was also the case in our series. Yet the significant differences by analyses of variance between regions in boys and girls (boys $F = 4.52$, $p < .035$; girls $F = 11.57$, $p < .001$) as well as those in weight in females ($F = 5.87$, $p < .017$, this was not significant in boys), are partly due to the differences in age between the two regions so that regression analysis was necessary.

Comparison of regression analyses gave significant F values with height on age for girls only (*Figure 1b;* girls $F = 5.54$, $p < .020$) but these were not significant for either sex with weight on age (*Fig. 1a*). The significant equation with only height in the girls is interesting in that this difference points to a different growth rate in the two parts of Italy in females but not in boys.

The rather impressive high weight for height of the girls in the South however, resulting from the regression of weight on height compared to that of the girls from the North and Center (*Figure 1c*) may also reflect the still traditional way of living in rural areas as cited by D'Amicis et al. (1985) who reported significantly higher weight of girls from an area 200 km South of Naples on the Tirrenian coast (+ 0.8 Kg, $p < 0.05$ compared to NHCHS Growth standards).

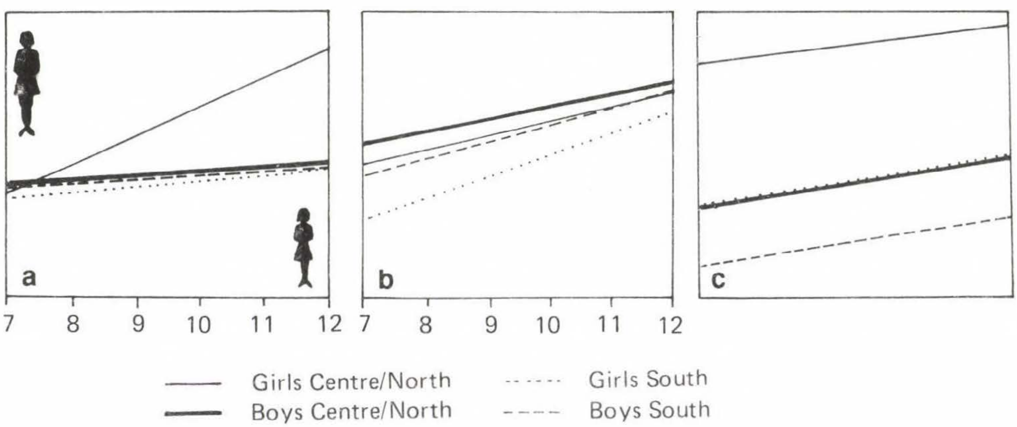

Fig. 1: a) Regression of $^3\sqrt{}$ Weight on Age in Italian Schoolchildren; b) Regression of Height on Age in Italian Schoolchildren; c) Regression of $^3\sqrt{}$ Weight on Height in Italian Schoolchildren

Table 1. **Significantly different variables for verbal knowledge of the body between the two regions (N+C North+Center) of Italy in the two sexes**

Girls	N+C	South		Boys	N+C	South	
Chin	+ 59	50	p < .014		+ 91	44	p < .00065
	− 1	8			− 4	13	
Elbow	+ 60	51	p < .0057		+ 94	52	p < .028
	− 0	7			− 1	5	
Cheek		not significant			+ 95	52	p < .0066
					− 0	5	
Shoulder		not significant			+ 94	52	p < .028
					− 1	5	
Lashes		not significant			+ 91	44	p < .00065
					− 4	13	
Buttocks		not significant			+ 45	15	p < .016
					− 50	42	
Ancles		not significant			+ 87	39	p < .0006
					− 8	18	

Verbal knowledge of the body

When variables are taken one by one there are some significant differences in knowledge of body names in males and less marked also in females between the two areas (*Table 1*), children in the South being consistently less knowledgable. With the

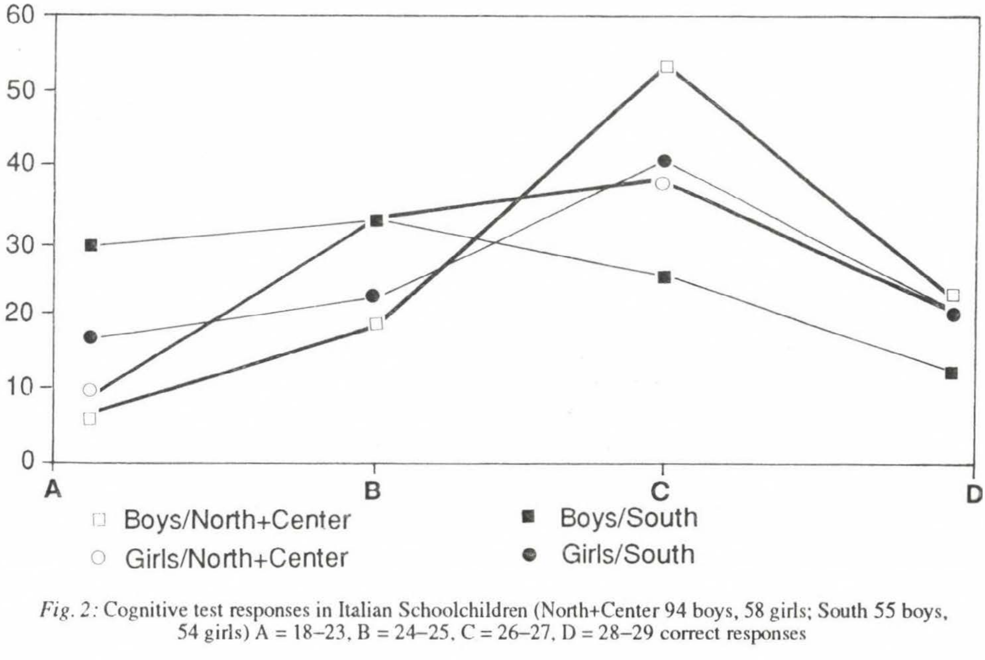

Fig. 2: Cognitive test responses in Italian Schoolchildren (North+Center 94 boys, 58 girls; South 55 boys, 54 girls) A = 18–23, B = 24–25, C = 26–27, D = 28–29 correct responses

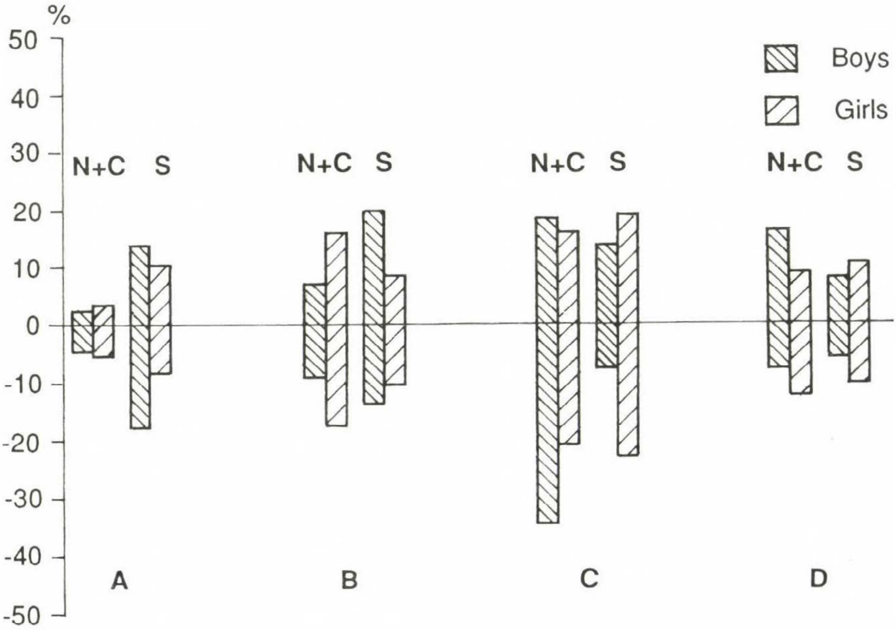

Fig. 3a: Cognitive test results. Knowledge of names of body parts of Italian schoolchidren Classification by regression residuals $^3\surd$ Weight on Age

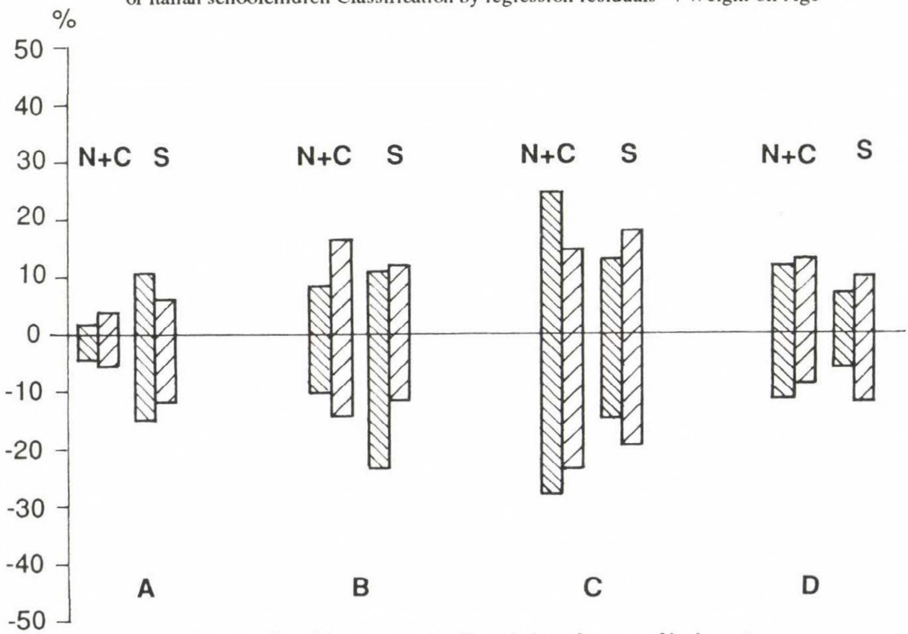

Fig. 3b: Cognitive test results. Knowledge of names of body parts of Italian schoolchidren Classification by regression residuals $^3\surd$ Weight on Height

boys this is clearly evident also for the four groups (correct responses pooled according to increasing knowledge; A minimum, D maximum), but only tendencies in girls (*Figure 2*).

However, when these four groups of cognitive test results are differentiated by their position above and below the regression line fitted for the third root of weight on age (*Figure 3a*) and by their position above and below the regression line fitted for the third root of weight on height (*Figure 3b*) no significant differences in knowledge of names of body parts are verified neither between sexes in each region nor between regions in each sex. The only significant results, observed for boys with weight on age ($\chi^2 = 4.78$) indicating that more boys who are heavy for their age knew more body parts is best interpreted as an artefact due to the number of tests done.

Psychomotor achievement

Pooling all the children into three groups: (1) achievement in psychomotor tasks one or more years ahead of its age, (2) achievement according to its own age, and (3) achievement one or more years behind its age and differentiating by sex and the two regions a significant excess of over achievers is observed in the North and Center by comparison with the South in both sexes (girls $\chi^2 = 22.6$; $p < .0001$; boys $\chi^2 = 6.78$, $p < .034$; *Figure 4*).

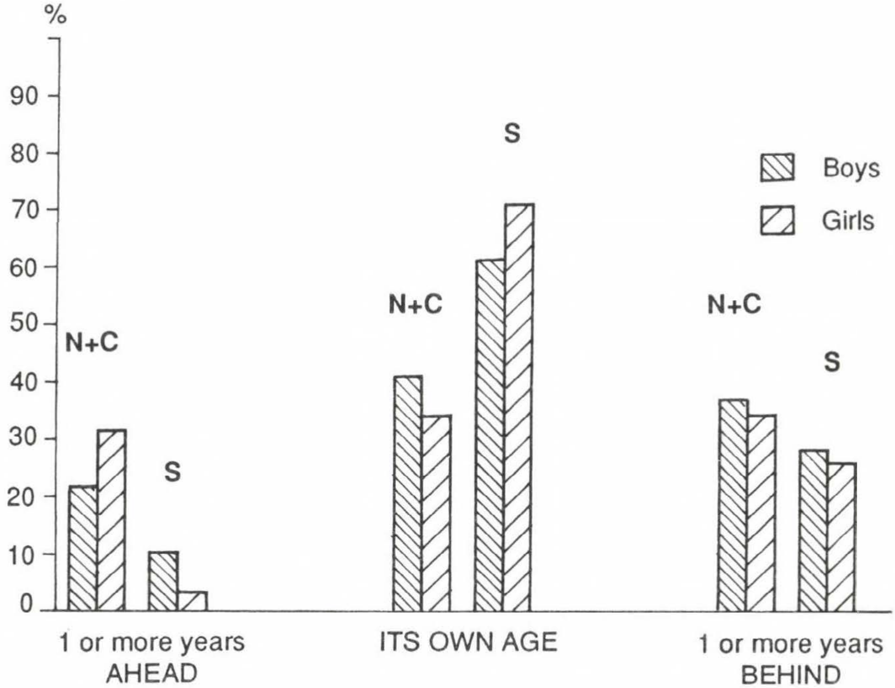

Fig. 4: Achievement in psychomotor tasks adjusted for age
(Boys: 105 North + Center, 57 South; Girls: 73 North + Center, 58 South)

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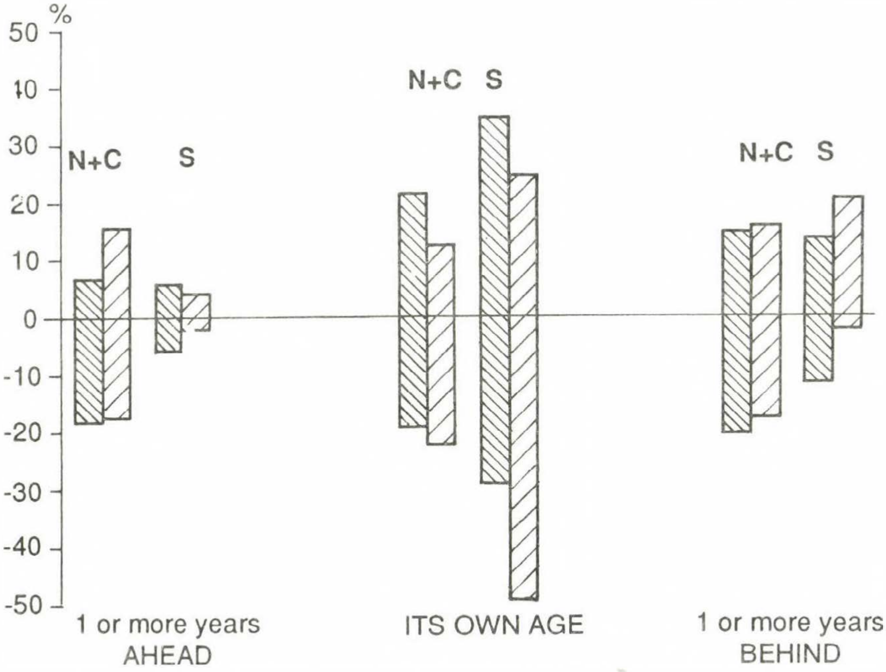

Fig. 5a: Achievement in psychomotor tasks. Classification by regression residuals
$^3\sqrt{}$ Weight on Age (Boys: 89 North + Center, 52 South; Girls: 64 North + Center, 49 South)

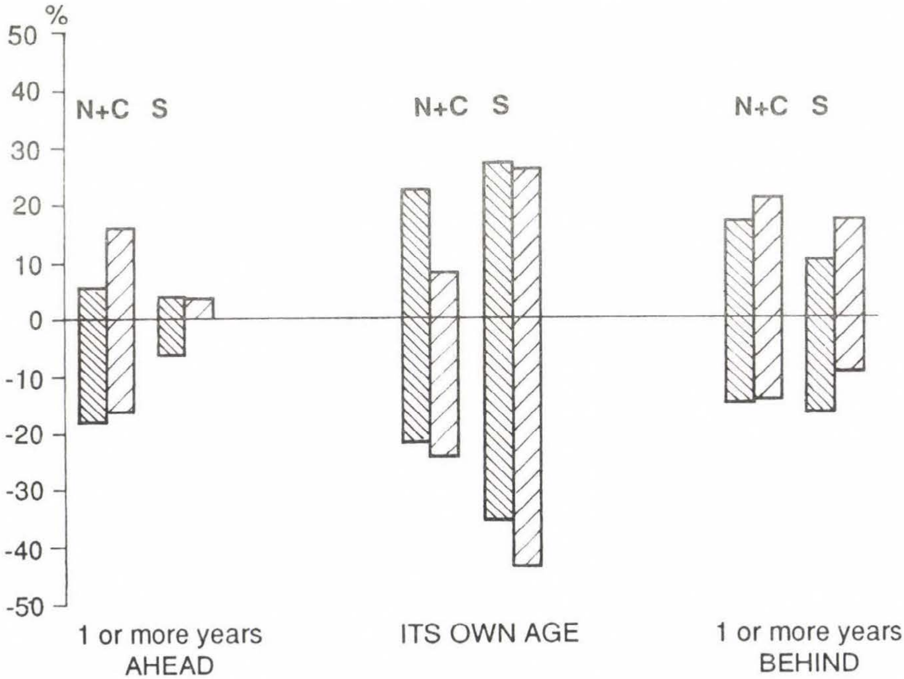

Fig. 5b: Achievement in psychomotor tasks. Classification by regression residuals
$^3\sqrt{}$ Weight on Height (Boys: 88 North + Center, 48 South; Girls: 62 North + Center, 53 South)

On account of these marked regional differencies in psychomotor achievement and in growth association with physique was investigated within regions and sexes. Regressions were fitted of third root of weight on age, and third root of weight on height for each sex and region and the residuals calculated for each child. Achievement was classified by whether the residual was positive or negative. As shown in *Figure 5a* in the North and Center more boys who overachieve are light for age but not significantly while with girls there is no association of over- or underachievement with weight for age but a tendency for those who achieve as expected to be light for age. In the South there is no difference in boys but with girls significantly more underachievers are heavy for their age ($\chi^2 = 7.92$) and more who achieve as expected are light for age ($\chi^2 = 11.56$).

The picture is similar with regressions fitted for the third root of weight on height. With girls in both areas there are tendencies for those who achieve as expected for age to be slender and those who underachieve to be plump but not significantly; with the boys in the North and Center overachievers tend to be slender but there is not even a tendency in the boys from the South (*Figure 5b*). These observations, though not directly comparable on account of different tests applied are of general accordance with those reported by others (Welcon & Sekita 1975, Malina 1984) stating that considerable subcutaneous fat in a child is associated with less agility and power, i.e. excess weight may function as a handicapping factor.

For a long time it has been known that there are biological differences between different areas of Italy ranging from genetic markers (Piazza et al. 1989) to body dimensions (Ente Italiano della Moda 1979). The present study confirms the latter but also suggests that similar differences may exist in general dynamic coordination and cognitive knowledge of the body. The extent to which these differences are intrinsic or results of environmental differences remains to be determined.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 8 August, 1991.

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Anthrop. Közl. *33;* 229–233. (1991)

NUMBER OF HANDICAPPED CHILDREN IN HUNGARY

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Abstract: *The authors review the number and the ratio of handicapped children compared to the total number of primary school pupils. The study is based on educational statistics in Hungary from the 1954–55 schoolyear till today about children aged 6 to 14 years.*

First, the Hungarian interpretation of different groups of the handicapped, i.e. mentally retarded, hearing impaired, visually handicapped and physically handicapped will be introduced.

During the first three decades the number of registered handicapped pupils increased steadily, in spite of the well-known changes of the number of primary schoolchildren. This phenomenon indicates a real increase of the care for the special population.

In the previous (1989–90) schoolyear, the percentage of the primary school children and the pupils of special school for mentally retarded, hearing impaired, visually and physically handicapped was 96.74, 3.02, 0.10, 0.04 and 0.10, respectively.

Key words: *Number of primary schoolchildren; Number of disabled children, Hungary*

Introduction

As it was demonstrated by the statistical data of UNO one tenth of the population in the world in at least one respect is disabled. This problem has been followed in Hungary for two decades by studying mainly the school statistics and the national censuses taken in every ten years in this country. The statistics are based on the registrated status of 1st of October in every year and have been published by the Ministry of Education since the 1954–55 schoolyear. These data include the primary schoolchildren, aged from 6 to 14 years. In Hungary all of the handicapped children attend some separate special school or registered in a school with a special aid of peripathetic teacher.

It seems to be necessary to summarize the meaning of some cathegories, as they are used in Hungary.

1. *Mental deficiency* is a permanent disturbance of the cognitive functions: i.e. a pathological diminuation of the level of intelligence. From the educational point of view, *mentally retarded children* are devided into three groups: slightly deficient (their IQ is between 70 and 50), moderately deficient (with IQ between 50 and 25) and seriously deficient (with IQ under 25). It is to be noted that IQ between 80 and 70 usually means slow mental development, but not mental deficiency.

2. In the case of *children with hearing impairment* the natural development of speech is obstructed by the impairment of central or peripherial part of auditory system.

2.1. Children with *moderate hearing* have speech receptive threshold between 30 and 50 dB. They are educated in regular primary schools with a special aid of speech therapist.

2.2. In the case of children with *serious hearing disability* the speech-receptive threshold is in the range of 40 and 80 dB. Their education is carried out at special school for weak of hearing, or sometimes in primary schools using hearing-aid equipments.

2.3. Children are titled as *deaf* with hearing loss more than 80 dB. They are educated in eight special schools for the deaf.

3. From the pedagogical point of view, the sight of *visually handicapped children* is reduced by more than 67% and due to this fact, development of their personality deviates from the normally sighted persons. These children are devided into three groups:

3.1. *Partially sighted children* have a visus of 33 to 10 percent of the normal one. They are educated in two special schools for partially sighted under special conditions, or sometimes in primary schools with appropriate glasses.

3.2. The degree of sight reduction of *practically blind children* is more than 90%. Their residual sight is not enough to build up a visual way of life. Therefore their education is aimed at the blind way of life including the teaching of the Braille alphabet.

3.3. *Blind children* are not even perceiving light and they are educated at special school for the blind.

4. The motion organs of *physically handicapped children* are permanently restricted.

4.1. The *spastic paralysis* is caused by the lesion of the motoric part of the central nervous system. A typical form of which is CP or by previous name: Little syndrome. One of the main features of it is the spasm of the muscle.

4.2. The most important characteristic of the flaccid form is the *atony of the muscle*. The well-known type of it is the Heine-Medin disease but this form does not exist in Hungary any longer after the use of Salk and Sabin vaccine.

These "pure" forms of disability are going to be more and more rare, and the multiple forms are occure the most frequently. These children are educated in special schools corresponding to the main disabilities e.g. blind and mentally retarded are educated at the school for blind.

Before discussing the results it is necessary to make one further remark: a child attending a special school or living in a special institution on 1th of October is qualified as a *disabled* – in the statistics.

Results

The results are presented on the *Fig. 1*. The different kinds of disabilities were considered separately without differentiating between the different levels of seriousness. The logaritmic scale was used on the ordinate of this diagram.

Two bumps can be seen in the curve of primary school children. It is a multifactorial phenomenon of course, but perhaps the main reason of it are as follow: The first bump is due to an anti-abortation law of the late 40's. Its influence can be observed from the end of the 50's. In June 1956 the atrificial abortation was allowed. Therefore the number of births and then ten years was the year of issue of the child care allovance law. As a consequence of which the number of primary school children decreased as well. 1967 was the year of issue of the child care allovance law. As a consequence of which the number of primary school children started increasing in the 1972–73 schoolyear. For the last five years this number has been decreasing again probably due to the economic situation of the country.

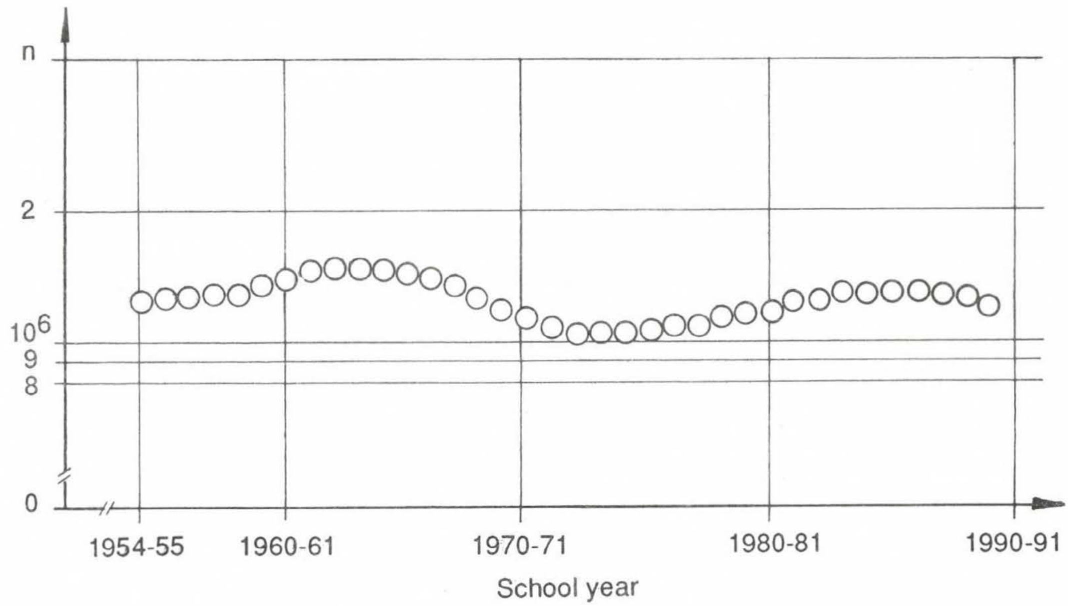

Fig. 1: Changes of number of Hungarian primary schoolchildren.
Logaritmic scale was used at the ordinate

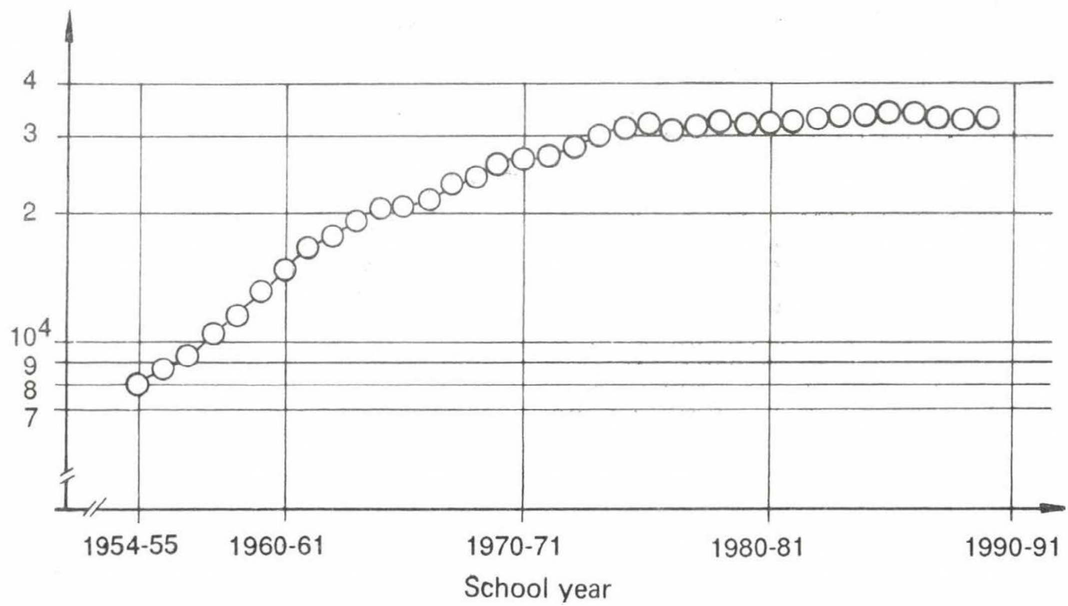

Fig. 2: Changes of number of registered mentally retarded children.
Logaritmic scale was used at the ordinate

The number of mentally handicapped children (*Fig.* 2) increased almost monotonously from the first studied schoolyear up to 1985–86 however this increase is not significant during the last ten years.

The number of hearing impaired (*Fig. 3*) children stagnates in the examined period: it is between 1300 and 1600.

The number of visually and physically handicapped children also increases. The number of visually handicapped ones is under 600 pupils, and that of the physically handicapped children is still less then before the 1983–84 schoolyear. Their number has increased substantially since that time due to the increasing number of pupils of the Pető Institution.

There are two suspected factors behind these numbers. The main factor is, without any doubt, the development of the *institutionalized care of disabled.* But we cannot exclude the real increase of the number of these children. Similar expectations are suggested for the turn of the century by these factors and those are defined as our future tasks.

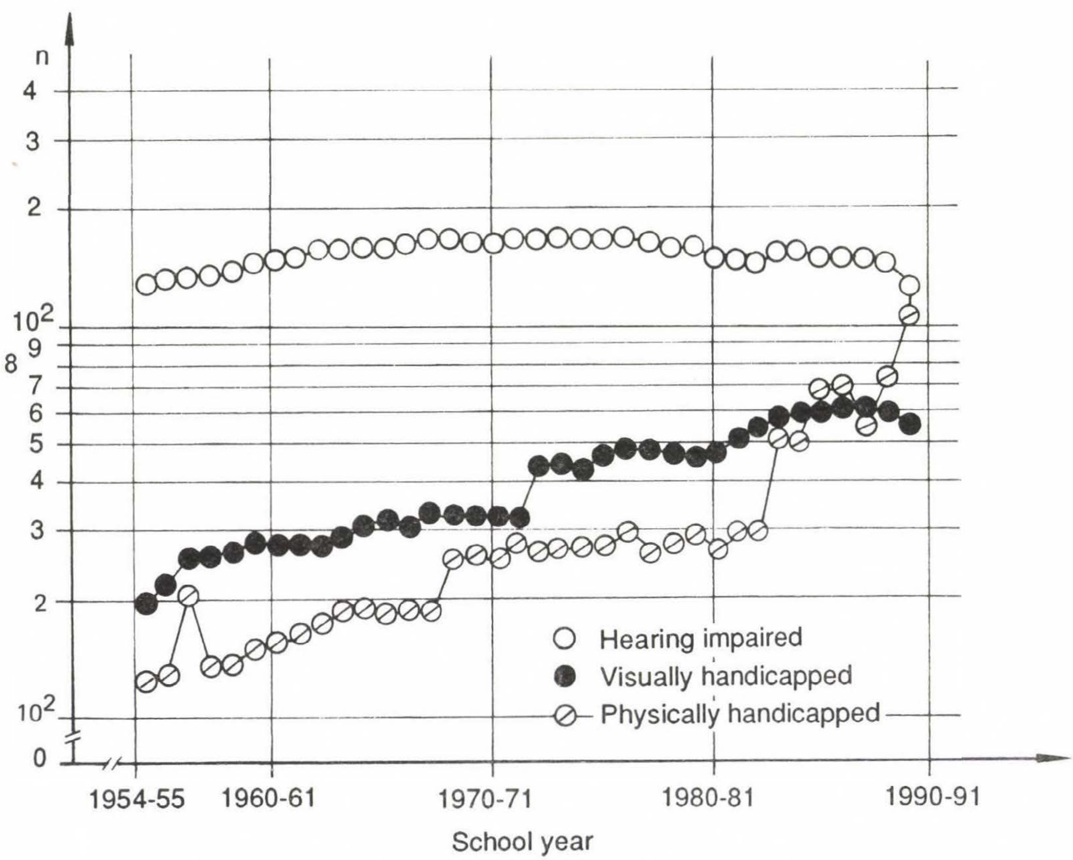

Fig. 3: Changes of number of registered hearing impaired (O), visually handicapped (●), and physically handicapped (∅) children. Logaritmic scale was used at the ordinate

The first task can be summarized as *prevention:* this is the task of genetic councellors and other medical efforts. But we are afraid that the real solution of these problems is out of the responsibility of professoinals. As one may know, the rate of prematurity is ca astrophally high in this country. One part of these newborns are so called "small for date baby". These babies can damaged easily and some years later we often see them as a disabled. The decrease of their number would be very important but it probably can be solved by the general development of economic and social situation of the country.

After their birth, disabled children have special rights, declared by UNO. Therefore we have to make special efforts for their health and also for their (re)habilitation.

This paper is perhaps beside the theme of our symposium, but we thought, that disabled children are also part of the young generation of a country. In school ages their total number is around 40 000. This size of the popultation is big enough to take the problem into consideration.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 13 September, 1991.

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Anthrop. Közl. *33;* 235–241. (1991)

PHYSICAL FITNESS DIFFERENCES IN HUNGARIAN SCHOOL-AGE CHILDREN WITH SPECIAL REGARD TO EXPLOSIVE LEG STRENGTH

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Abstract: *The physical fitness status refers to and reflects the influence of environmental and ecological conditions. Futhermore, the attitudes and behaviour patterns of a given social setting determine to a large extent the life style and amount of physical activity. This paper refers to a large scale research project "National Growth Study", focused on biological development of the Hungarian youth at the end of the 20th century. Regional and environmental differences regarding children's physical performance were found in their dynamic strength, too.*

The results of our first National Growth Study made it possible for us to watch trends in growth and physical fitness of children and youth and to assess the influence exerted on these trends by different conditions. The foundings of complex investigation could give the answers to the important question to what extend violent changeds which took place in Hungary during the past years, have been reflected by the development of children and youth, and what has to be changed for the new generations' health-related physical fitness.

Key words: *Health-related fitness; Explosive leg strength; Hungarian youth; Social influences.*

Introduction

The physical fitness of school-age children has received considerable attention in recent years in Hungary, too. The special appreciation is due to the growing concern that habitual physical activity levels may be declining in the young. Beside this, there is a wellknown protest from armed services recruitement centres that young recruits are at a low standard of fitness. The Youth Sport Association has emphasized a sharp decline in organisewd competitive sport is Hungarian schools.

With regard to these facts the investigation of biological development and physicawl performance capacities of Hungarian youth was initiated at the end of the 20th century (Eiben – Pantó 1981, 1986, Barabás 1986). The studies were supported by the Institute of Social Sciences and the National Sport Office. The survey concerning anthropometrical measurements and physical performance should emphasize the relationship between the health and physical activity and monitoring the aspects of positive health, health-related fitness.

The most useful definitions of fitness draw a clear distinction between fitness, as related to "performance" that is specifically an athletic or industrial task and fitness that is related primarily to functional health. The term of "health-related fitness" has been used for a couple of years (Safrit 1986, Tuxworth 1988. Aahperd 1980, Eurofit 1988).

The general concept of physical fitness can be divided in three major divisions: the organic, the motor and the cultural component (Renson et al. 1979).

However, the basic factor of the health-related fitness is the cardiorespiratory fitness which is in relationship with the organic (i.e. physique) and motor (i.e. motor fitness) of physical fitness. There are other elements claimed to be linked to health, mainly the joint flexibility together with abdominal endurance, the strength and its associated capacities, power as well as static and dynamic, agility and so on. The motor fitness that is a m ltidimensional component, can be measured only through a battery of test, each of them measuring different factors. Although a cross-sectional examination has by definition certain limits, one can still draw certain conclusions concerning the development of motor abilities, such as strength, speed and endurance.

In this study there are some organic and cultural comoponents discussed, based on the standing broad jumb test which is evaluating the explosive leg strength.

Material and Methods

The size of the examined sample contained approximately 28 000 schoolchildren, the 1.5 per cent of 6–18 year-old healthy children of both sexes in Hungary (*Table 1*). The sample represents all types of settlements and all types of schools (in Hungary there are three types of secondary schools: grammar, specialised and vocational-training schools).

Table 1. **Number of subject examined**

Age (years)	Boys	Girls
6	200	209
7	1066	950
8	1168	950
9	1261	1151
10	1160	1099
11	1176	1079
12	1107	1055
13	1165	1079
14	1164	1069
15	1551	1224
16	1577	1074
17	1328	936
18	737	537
over 18	97	59
Total	14758	12672

The investigation was connected functionally to Eiben's "The Hungarian National Growth Study" (Eiben – Pantó 1981). Different jump tests were used to evaluating the explosive leg strength. We chose the standing broad jump test (Barabás 1984). Data were elaborated with the multivariate discriminant analysis and variance analysis on IBM 3010 computer with SPSS–X program-package.

Results and Discussion

Standing broad jump results related to height and weight (i.e. organic components of physical fitness) at every age groups, more exactly characterize performances of subjects (for deteils see Eiben – Pantó 1987–88, and Barabás 1986). *Figures 1* and *2* show the age-group differencees of height, weight and jumping scores for boys and girls.

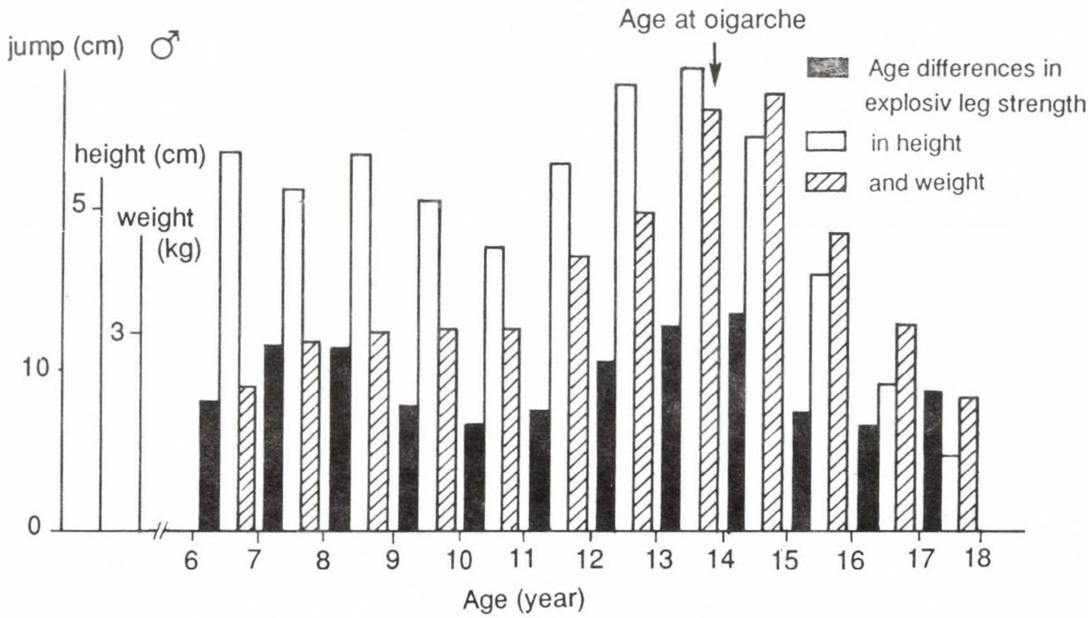

Fig. 1: Girls' performance differences between the consecutive age-groups

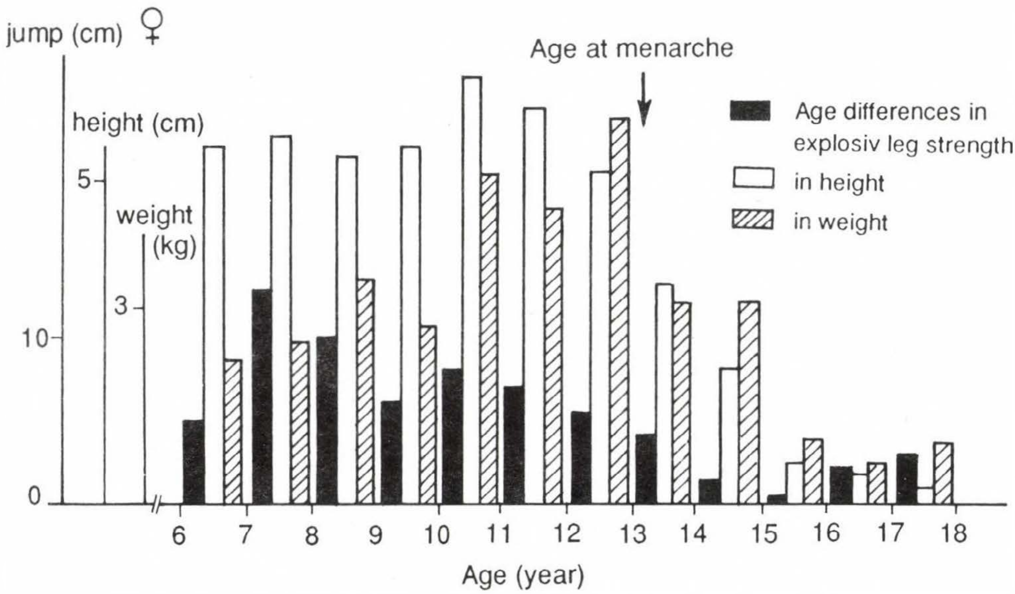

Fig. 2: Boys' performance differences between the consecutive age-groups

The optimal case would be that the body weight increase according to age, would mean a proportionally bigger mass of muscles, to which could result in better performances. However, this assumption is only partially justifiable in the case of girls. The increase of body weight is to a great extent caused in connection with sexual characteristics by the growth of fat tissues. On the other hand, the greater body weight bears greater inertia and therefore greater strength would be necessary to mobilize this body weight from its state of rest (Malina 1980).

There are positive and negative correlations between the performance and body measurements (*Table 2*). In the case of boys the strenght development reaches the ighest peak only when peak of height and peak of weight have changed, that is the spurt-like development after puberty. While in the case of girls the performance results are levelling off after puberty (Barabás 1986).

Table 2. **Pearson correlations (r, p) between standing broad jump performances and body measurements (height, weight) in boys and girls**

Age (year)	– Height r	p	– Weight r	p
Boys				
6	.0418	.287	.0797	.141
7	.0150	.316	.1609	.000
8	– .0514	.043	.0863	.002
9	– .0746	.005	.0609	.017
10	– .0974	.001	.0947	.001
11	– .1446	.000	.0349	.120
12	– .1152	.000	.1144	.000
13	.0076	.000	.2264	.000
14	.1014	.000	.3165	.000
15	.0822	.001	.2278	.000
16	– .0289	.134	.1780	.000
17	.0124	.332	.1848	.000
18	– .0950	.006	.1386	.000
Girls				
6	.0699	.000	.4131	.000
7	– .0895	.004	.0808	.000
8	– .0093	.379	.1324	.000
9	– .0598	.024	.1298	.000
10	– .1305	.000	.0898	.002
11	– .0916	.002	.0659	.018
12	– .0462	.072	.1806	.000
13	– .1436	.000	.0670	.016
14	– .1084	.000	.0993	.001
15	– .1511	.000	.0662	.011
16	– .0847	.003	.1386	.000
17	– .0500	.067	.1889	.000
18	– .2042	.000	.1051	.008

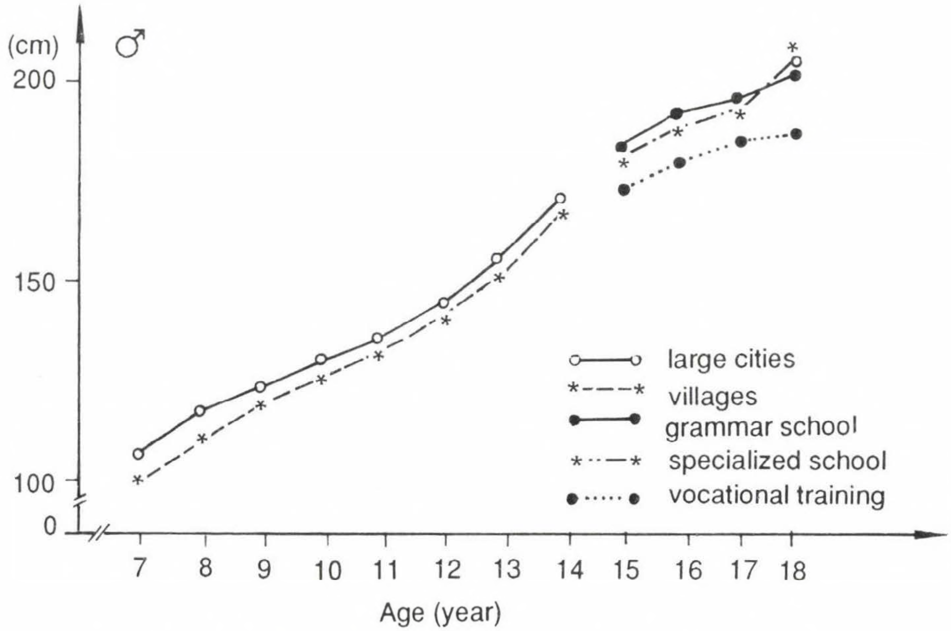

Fig. 3: Performances in standing broad jump of boys living in different circumstances

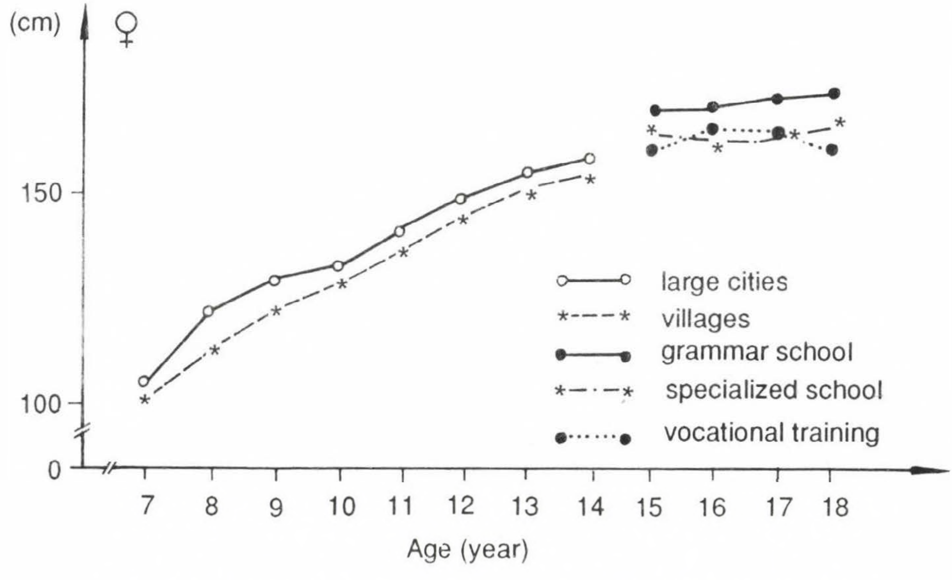

Fig. 4: Performances in standing broad jump of girls living in different circumstances

Beside the organic component the physical fitness is also influenced by the cultural component of physical fitness. This refers to the social influences such as for instance the situation of physical education in the school-system or furthermore the change of evaluate system (Laki – Makszin 1986). The attitudes and behaviour of a given cultural setting determine to a large extent the life style and movement activities of an individual. These are mainly determined by the type of settlements (which is a consequence of the number of inhabitants) and the type of schools (which is reflecting the differences among the settlements!) and that is the consequence of the social structure.

Figures 3 and *4* show the *performance differences* of boys and girls being in different circumstances. The *standing broad jump* results of 6–14 year-old children living in cities or villages are different. Our preliminary results let us know that the largest separations are between the cities and villages, referring to the physical performance of youth (Barabás – Fábián 1988). Another emphasized separation is in the case of secondary school-type. The performances of 14–18 year-old boys and girls are different in the jump test according to their secondaary school-type (*Fig. 3* and *4*). The largest differences can be seen between the performances of grammar schoolchildren and the vocational-training schoolchildren (Barabás 1989). That is the evidence of recruiting possibilities of secondary school-system, determined by the forced urbanisation, development of the industrialized cities as against the rural areas, like small villages. There is some social selection, too.

Conclusion

Humanized life, the equal possibilities are human rights. The development and prospering of a settlement must depend only on the intellectual power and venture of their inhabitants. It is important for the whole community to accept responsibility for ensuring that school-age children (youth) achieve and maintain physically active life. Liasons among the schools, parents, sport associations and health professionals is the only way to make effective programs based mutual understanding of the nature and seriousness of the problem, in order to preserve the health of the next generations and young adults of the society.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 18 October, 1991.

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Anthrop. Közl. *33*; 243–247. (1991)

GYMNASTIC PERFORMANCE AS RELATED TO ANTHROPOMETRIC AND SOMATOTYPE CHARACTERISTICS IN MALE GYMNASTS

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Abstract: *The purpose of this study was to investigate the relation between body type characteristics and performance in male gymnasts of outstanding level. During the 24th World Championships Artistic Gymnastics, held at Rotterdam 1987, 165 male gymnasts were investigated. In total 19 body dimensions were measured and somatotype was anthropometrically determined according to the Heath-Carter technique. To investigate the relationship between physique and performance, the gymnasts were divided into three level categories (n varied between 20 and 22 for each group) on the basis of the final ranking scores obtained during the competition: lowest level (performance scores varied from 98.25 to 106.0); middle level (performance scores varied from 111.20 to 113.00) and highest level (performance scores varied from 115.05 to 117.00). Differencees between groups were analysed by means of an analysis of variance and Duncan's a posteriori tests. Results indicated that significant differences between group means were found for height, sitting height, leg lenght, forearm length, humerus and femur widths, biceps, triceps and calf skinfolds, weight, and the endomorphy component. The lowest level category obtained in general higher mean values on these variables in comparison with the middle and the highest level categories. It was also demonstrated that the gymnasts of the lowest level group were significantly younger than the gymnasts of the other two level groups with mean chronological ages of 20.46, 21.80 and 22.13 years, respectively. It can thus be stated that, even on the highest level of gymnastic competition, a significant differentiation in body build between placers and non-placers can be observed, indicating that physical characteristics are to some degree selective parameters for top level artistic gymnastics.*

Key words: *Anthropometry; Somatotype; Gymnastic performance; Males*

Introduction

It is a well-known fact that top sportsmen and women have a different physical build to the average population, and also that there are physical differences between athletes practising different sports and/or different events within a particular sport (Carter 1984). Studies of Olympic gymnasts (Carter et al. 1982) and other world-class gymnasts (Claessens et al. 1991) show that compared to the average population, these athletes have a smaller lenght development and a thinner build, with less subcutaneous fat. Although they have smaller circumference measurements in absolute terms, leading gymnasts tend to have developed relatively large muscles. It is clear that there are a variety of reasons for this differentiation, including selection and training. However only sporadic research has been carried out concerning the question whether there is still a relation between body constitution and highly skilled gymnastic performance within the outstanding male gymnasts and so far, only a limited number of variables such as age, height and weight (Carter et al. 1971, Gajdos 1984; Lopez et al. 1979) and somatotype (Carter et al. 1971, Lopez et al. 1979) have been examined. These studies show that, generally speaking, top-ranking gymnasts have a smaller stature and weight less than middle-ranking ones, and are more likely to be mesomorphic and less likely to have an endomorphic and ectomorphic somatotype. The purpose of this study was to explore the relationship between physical build and artistic gymnastic performance in top international gymnasts.

Material and Methods

A total of 165 gymnasts were examined during the 24th World Championships Artistic Gymnastics, held in Rotterdam, the Netherlands, from 18 to 25 October 1987. The subjects came from a total of 35 different countries. Most of them were Caucasian (n = 126); the others were Asiatic (n = 27); Negroid (n = 4) or mixed-race (n = 7). Their average age was 21.9 ± 2.4 years, varying from 16.0 to 28.6 years. A total of 19 body measurements were taken (see *Table 1*). Subject's somatotypes were also determined using Heath-Carter's anthropometric technique (Carter & Heath 1990). The somatotype ponderal index (= height/weight**1/3) and the total of three skinfolds (Triceps + subscapular + suprailiac) were also calculated. For a detailed description of these measurements and the procedures used for this project, reference is given to Claessens et al. (1991). In order to examine the relationship between performance and physical characteristics, three separate groups were set up based on the total points the gymnasts achieved in the free and compulsory events (max. points = 120) during the World Championships: (1) a lowest level group (n = 20) with a points total between 98.25 and 106.00; (2) a middle level group (n = 20) with a points total between 111.20 and 113.00; and a highest level group (n = 22) with a points total between 115.05 and 117.10. The differences in body dimensions and somatotype between the three groups were examined using an analysis of variance and Duncan's a posteriori tests.

Results

The results of the analysis of variance for the physical characteristics and the somatotype components for the three groups are shown in *Table 1*. This shows that gymnasts belonging to the lower level showed significantly greater figures for all lenght measurements than those in the middle and highest level groups. Between these two latter groups, however, there was no significant difference in lenght development. In terms of height, for example, the lower-ranking gymnasts were on average 6.5 cm taller than the higher-ranking. In terms of width measurements, only significant differences were found for the humerus width ($p < 0.05$) and the femur width ($p < 0.01$), with the lowest level group showing the highest average values of 7.2 cm and 9.5 cm, respectively. Although this group also had broader shoulders and hips, these measurements did not differ significantly from those of the two other grooups. All skinfold measurements were on average higher for group 1 than those of groups 2 and 3. The biceps skinfold and the sum of skinfolds were significantly ($p < 0.05$) higher in the lowest level group compared with the highest level group, but neither differed significantly from the average of the middle level group. The lower-ranking gymnasts also showed significantly higher skinfold measurements for the triceps ($p < 0.05$) and calf ($p < 0.01$) than the middle-ranking and higher-ranking groups. These differences in skinfold values can also been seen in the significantly ($p < 0.05$) higher average endomorphic component in group 1 than in group 3, with mean values of 1.7 and 1.5, respectively. Although there were no significant differences in circumference measurements, the lowest level group had smaller upper limb girths (except for the forearm circumference), but larger lower limb circumferences. Finally, the higher-ranking and middle-ranking groups were significantly older ($p < 0.05$) than the lower-ranking group, with average ages of 21.8, 22.1 and 20.5 years, respectively.

Table 1. **Analysis of differences in anthropometric and somatotype characteristics among three level groups of highly skilled male gymnasts (Data Rotterdam 1987)**

Characteristics	F-value	DUNCAN'S a posteriori test		
Age (years)	3.85*	22.1 (2)	21.8 (3)	20.5 (1)
Weight (kg)	5.21**	66.3 (1)	62.8 (2)	60.5 (3)
Height (cm)	7.11**	170.6 (1)	165.3 (2)	164.1 (3)
Sitting height (cm)	7.27**	90.5 (1)	88.6 (2)	87.1 (3)
Leg lenght (cm)	4.07*	80.1 (1)	77.0 (3)	76.7 (2)
Forearm lenght (cm)	5.94**	25.4 (1)	24.5 (2)	24.0 (3)
Biacr. diam. (cm)	2.07	39.2 (1)	38.3 (3)	38.2 (2)
Biiliac diam. (cm)	0.30	26.4 (1)	26.3 (2)	26.1 (3)
Humerus width (cm)	4.54*	7.2 (1)	7.0 (2)	6.9 (3)
Femur width (cm)	5.30**	9.5 (1)	9.2 (2)	9.0 (3)
Biceps girth (cm)	0.81	34.8 (2)	34.2 (3)	34.2 (1)
Upperarm girth (cm)	1.32	31.7 (2)	30.9 (3)	30.9 (1)
Forearm girth (cm)	0.79	27.7 (1)	27.5 (2)	27.2 (3)
Thigh girth (cm)	1.45	51.5 (1)	51.0 (2)	49.9 (3)
Calf girth (cm)	0.45	34.9 (1)	34.5 (3)	34.5 (2)
Biceps skinfold (mm)	3.29*	3.5 (1)	3.3 (2)	3.1 (3)
Triceps skinfold (mm)	7.22*	6.2 (1)	5.1 (2)	5.1 (3)
Subscap. skinfold (mm)	0.89	7.7 (1)	7.4 (2)	7.3 (3)
Suprailiac skinfold (mm)	0.79	4.1 (1)	4.0 (2)	3.9 (3)
Calf skinfold (mm)	10.84**	5.3 (1)	4.4 (2)	4.3 (3)
Sum skinfolds (mm)	3.28*	18.1 (1)	16.5 (2)	16.2 (3)
Endomorphy	3.24*	1.7 (1)	1.5 (2)	1.5 (3)
Mesomorphy	2.27	5.8 (2)	5.7 (3)	5.4 (1)
Ectomorphy	1.93	2.3 (1)	2.1 (3)	1.9 (2)
Somatotype Pond. Index	1.93	42.2 (1)	41.9 (3)	41.6 (2)

* = $p < 0.05$ / ** = $p < 0.01$
--- = the underlined mean values do not differ significantly
(1) = lowest classified group (N = 20)
(2) = middle classified group (N = 20)
(3) = highest classified group (N = 22)

Discussion

The results of this study show that there is a difference in physical characteristics between the highest and the lowest level world-class gymnasts. The best performers are characterised by a shorter lenght development as seen by a smaller height, sitting height, forearm lenght and lower leg lenght; have narrower limbs, and less subcutaneous fat, with smaller skinfold measurements and a lower endomorphic component. These results largely support the findings of Carter et al. (1971), Gajdos (1984), and Lopez et al. (1979). It is clear that this differentiation is affected by a number of factors, including selection and training. Since intense physical activity should not have any effect on body lenght development (Broekhoff 1986), we believe that the smaller lenght measurements of better gymnasts are due mainly to a process of selection. The relatively thicker layer of subcutaneous fat in less outstanding gymnasts is probably due largely to the fact that they train less frequently and less intensively. The training figures given by the subjects of this study show that the higher-ranking train for significantly ($p < 0.05$) more hours per week than the lower-ranking ones, at 25.4 hours and 19.8 hours, respectively. The training figures also show that the highest level gymnasts began gymnastics an average of one year earlier than the lowest level performers, with mean starting age values of 8.6 and 9.6 years, respectively. If we also take into account the fact that the best gymnasts are also chronological older than the less successful ones (21.8 and 20.5 years, respectively), there is an average difference of 2.3 years in the total time spent involved in gymnastics between the two groups. Another important factor may be the difference in ethnic background between the gymnasts in the different groups. A study by Le Veau et al. (1974) of the differences between world-class Japanese and American gymnasts shows that those of Asian origin are distinctly smaller, with shorter extremities but the same weight, indicating a more highly-developed musculature. But closer analysis of our figures, taking account of the gymnasts' ethnic background, shows that this is not a factor for the observed differences in this study. In fact there was no significant difference in somatic characteristics or somatotype between the 15 Causasian and 6 Asiatic gymnasts in the highest level group (in this group there only was one gymnast of Negroid ethnicity). The results of this study therefore indicate there is still a difference in body build between more successful and less successful gymnasts competing on the highest level, and it is likely that the selection factor plays an important part in this difference.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. *33;* 249–254. (1991)

COMPARISON OF SOMATOTYPES OF CZECHOSLOVAKIAN AND CANADIAN RHYTHMIC SPORTIVE GYMNASTS

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Abstract: *The purpose of this study was to describe secular changes in the physique of elite rhythmic sportive gymnasts occurring over the past 23 years. The study is part of a larger international project, the main focus of which is on the health of these athletes. The highly ectomorphic and prepubescent physique demonstrated by world top rhythmic sportive gymnasts and also the increasing number of reports of retarded growth and potentially dangerous dietary practices in related sports have inspired this study. The sample of Czechoslovakian rhythmic sportive gymnasts dates from 1967–68 and the last sample of Canadian rhythmic sportive gymnasts was obtained in 1991. Over the period of these years sport of rhythmic sportive gymnastics developed internationally and finally it was included into the Olympic Gamees in Los Angeles. Escalating demands on the technical aspects of the sport were accompanied by demands on the physique of the athletes.*

Key words: *Somatotypes; Rhythmic sportive gymnasts (Czechoslovakian and Canadian).*

Introduction

There is a growing concern about highly ectomorphic and prepubescent physique demonstrated by world top rhythmic sportive gymnasts. There is also an increasing number of studies of retarded growth and potentially dangerous dietary practices in so called aesthetic sports, particularly artistic gymnastics (Lewis and Eisemann 1989, Moffat 1984, Hickson et al. 1986, Loosli et al. 1986, Benson et al. 1990, Bernadot, Schwarz and Heller 1989, Calabrese 1985, Dummer 1987, Brooks-Gunn et al. 1987, Thorton 1990, Claessens et al. 1990, Claessens et al. 1991). Very little information exists on rhythmic sportive gymnastics. The maintenance of low adiposity, whether before or during puberty, requires extreme vigilance and could lead to overtraining, malnutrition, and/or eating disorders. It is well known, that many female athletes in aesthetic sports discontinue their athletic carriers prematurely, mostly due to the extreme requirements of training combined with strict diet. The authors believe that clarifying some trends and lifestyle practices in the sport of rhythmic sportive gymnastics may provide a foundation for maintaining gymnasts' good health as well as lengthen their competetive years.

Material and Methods

Baseline data were collected in Czechoslovakia, between 1967–68 by Brandova and Štěpnička (Štěpnička 1972). The sample of 74 rhythmic sportive gymnasts was measured and somatotypes evaluated first by method of Sheldon and later by that of Heath & Carter (Carter 1980).

Canadian data were collected in 1988 (Alexander 1989) and in 1990 and 1991 by the authors. The sample includes eight top national and sixteen elite provincial rhythmic sportive gymnasts. Comprehensive anthropometric measurements were taken according to the methods of Ross and Marfell-Jones (1990). Somatotypes were evaluated by the Heath – Carter method (Carter & Heath 1990). The sample of provincial elite gymnast was divided into three arbitrary age groups: less than 13 year-old, N = 7; 13–16, N = 5; 16 and above, N = 4. These groups were also compared with the same age groups of school children from the 1974 Coquitlam growth study (COGRO 1974) N = 107, 138 and 78 and with the University females N = 300 (1967/68) and N = 48 Kinesiology students (1990/91).

Results

Table 1 shows the average age, height and weight of three rhythmic sportive gymnastic samples.

The described samples were measured in a difference of more than twenty years. It is of interest to note that the height of all and especially the national team members is very similar, while the average age of the top rhythmic gymnasts decreased by more than five years and body mass decreased by app. 10 kg.

Table 1. **The three samples investigated**

Gamnasts	N	Age	Height (cm)	Weight (kg)
Czechoslovakian	74	19.9	163.50	57.05
Canadian National	8	15	164	49.6
Canadian Provincial	16	14	160	46.3

Figure 1 shows the somatotypes of Canadian provincial elite gymnasts (A: age 12.99 year and younger, B: age 13–16 year, C: age 16 year and older). A definite clustering is apparent, without a great deal of overlap among the groups. The age trend is for A to B, level of fatness is maintained but linearity is increasing slightly and musculo-skeletal robustness is dropping. Trend from B to C is much less linear and more ponderous.

Comparison with control groups of the same age children is shown in Somatochart 2 (Cogro groups D, E, F; *Fig. 2*). It is suggested that gymnasts show the physique manifestation of delayed puberty because normal female population is higher in endomorphy even at younger ages.

In *Figure 3* A represents 74 Czech rhythmic sportive gymnasts active in the 1970's, and B represents 16 Canadian provincial rhythmic sportive gymnasts active in the 1990's.

The group of contemporary gymnasts is much less ponderous, in part due to less adipposity and also very much related to less muscularity. The average somatotype of the Czech rhythmic sportive gymnasts in 1967/68 was 3.5–4.5–3.0, the same as the most frequent somatotype of track and field athletes in those years. Somatotypes of both contemporary samples show a great degree of ectomorphy. In evaluation of these findings, consideration was given to: ethnic or national differences; age differences; changes in sport specific requirements.

Figure 4 represents average groups of normal university female students: A: Czech rhythmic gymnasts 1967/68, B: Canadian provincial rhythmic sportive gymnasts 1991, C: Czech students 1967/68, D: Canadian students 1990/91.

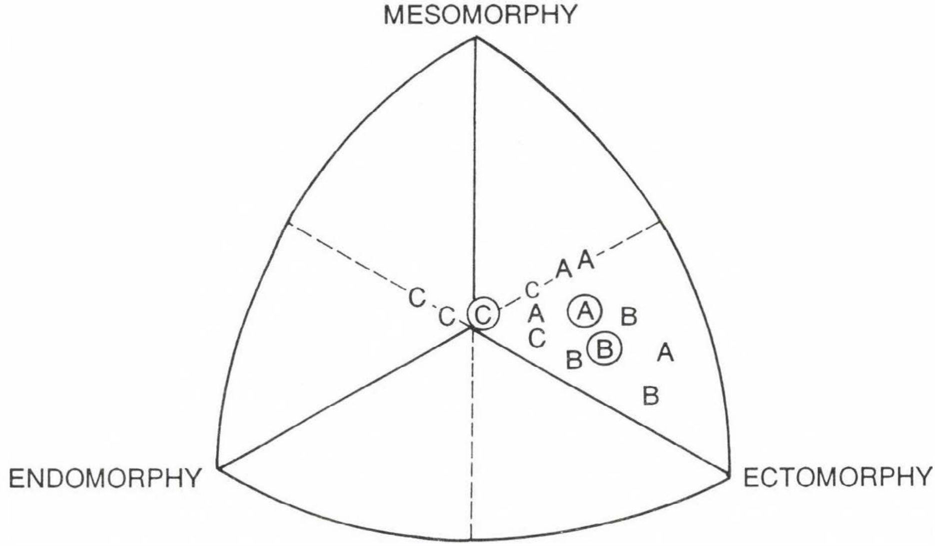

Fig. 1: Somatotypes of Canadian provincial elite female gymnasts. Group A: age 12.99 year and younger, N = 7, mean somatotype: 1.7–3.5–4.4; Group B: age 13–16 year, N = 5, mean somatotype: 1.7–2.8–4.8; Group C: age 16 year and older, N = 4, mean somatotype: 2.7–3.2–3.0. – The letters circled are the groups' means.

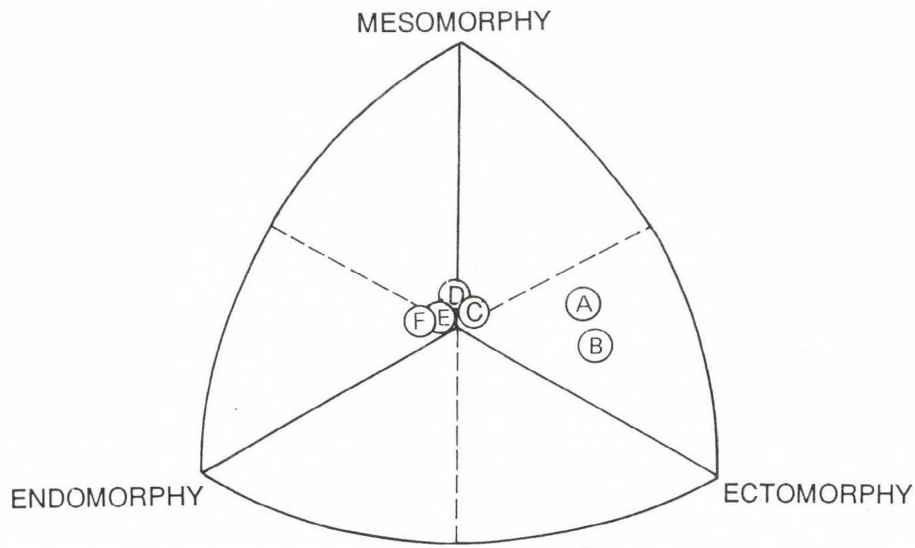

Fig. 2: Somatotypes of Canadian provincial elite female gymnasts and girls of COGRO. Group A: gymnasts, age 12.99 year and younger, N = 7, mean somatotype: 1.7–3.5–4.4; Group B: gymnasts, age 13–16, N = 5, mean somatotype: 1.7–2.8–4.8; Group C: gymnasts, age 16 year and older, N = 4, mean somatotype: 2.7–3.2–3.0; Group D: COGRO girls, age 9–13 year, N = 107, mean somatotype: 3.4–4.0–3.4; Group E: COGRO girls, age 13–16 year, N = 188, mean somatotype: 3.8–3.8–3.3; Group F: COGRO girls, age 16–18 year, N = 78, mean somatotype: 3.9–3.7–3.1

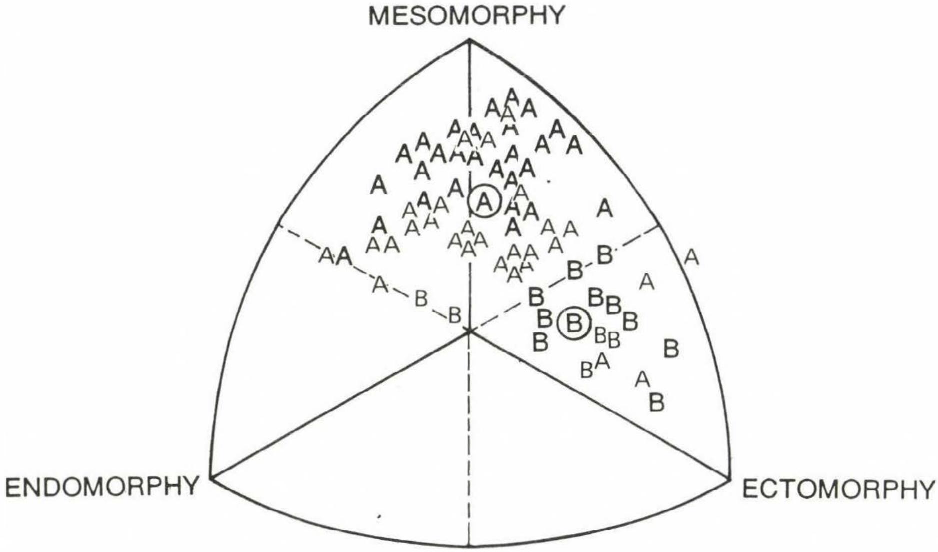

Fig. 3: Somatotypes of Czech and Canadian rhythmic sportive gymnasts. Group A: Czech rhythmic sportive gymnasts from 1967–68, N = 74, mean somatotype: 2.4–5.4–2.8; Group B: Canadian provincial rhythmic sportive gymnastst, 1991, N = 16, mean somatotype: 1.7–3.2–4.2

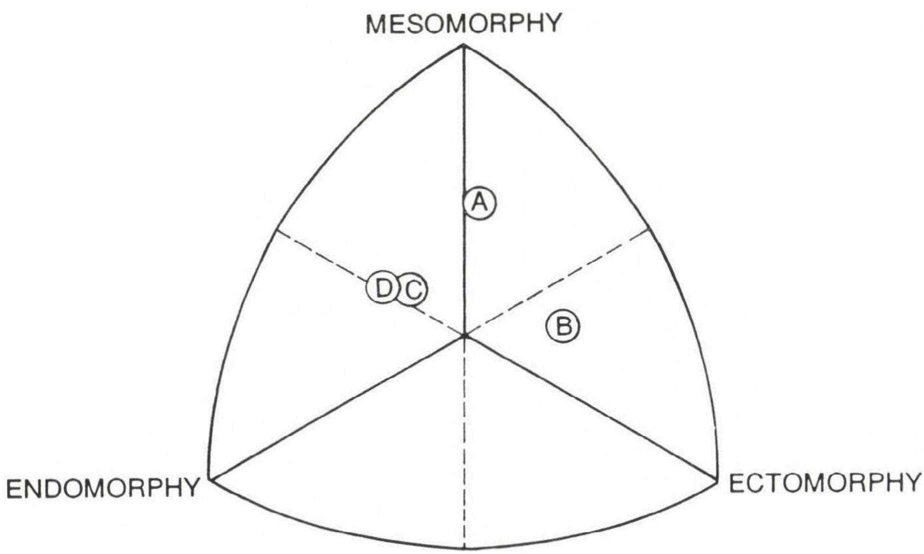

Fig. 4: Somatotypes of Czech and Canadian female university students and Czech and Canadian rhythmic sportive gymnasts. Group A: czech rhythmic sportive gymnasts from 1967–68, N = 74, mean somatotype: 2.4–5.4–2.8; Group B: Canadian provincial rhythmic sportive gymnasts, 1991, N = 16, mean somatotype: 1.7–3.2–4.2; Group C: Czech female university students, 1967–68, N = 300, mean somatotype: 3.9–4.3–2.7; Group D: Canadian female university (SFU Kinesiology) students, N = 18, mean somatotype: 4.2–4.3–2.3

Both groups of University students have almost identical group averages. This suggests that there are no differences in the student samples which are related to either secular or national/ethnic differences. This is, that there are no large differences between the base populations from which the gymnasts are selected.

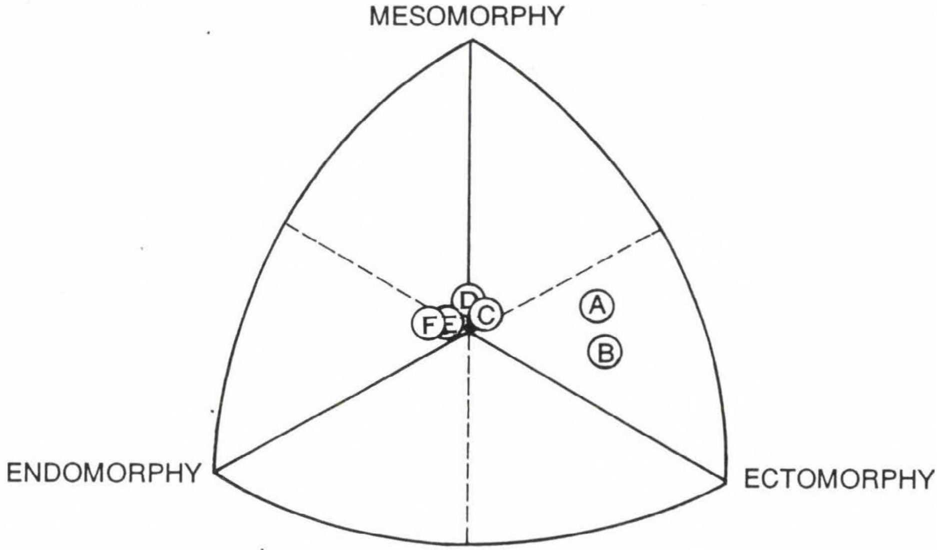

Fig. 5: Somatotypes of Canadian provincial elite female gymnasts and girls of COGRO. Group A: gymnasts, age 12.99 year and younger, N = 7, mean somatotype: 1.7–3.5–4.4; Group B: gymnasts, age 13–16 year, N = 5, mean somatotype: 1.7–2.8–4.8; Group C: gymnasts, age 16 year and older, N = 4, mean somatotype: 2.7–3.2–3.0; Group D: COGRO girls, age 9–13 year, N = 107, mean somatotype: 3.4–4.0–3.4; Group E: COGRO girls, age 13–16 year, N = 188, mean somatotype: 3.8–3.8–3.3; Group F: COGRO girls, age 16–18 year, N = 78, mean somatotype: 3.9–3.7–3.1

In *Figure 5* C, D and F are average somatotypes of school children (COGRO 1974) divided into age groups 9–13, 13–16 and 16–19 year-old. A, B and C are average somatotypes of previously mentioned Canadian provincial gymnasts divided into the same age groups. Groups of school children show just slight changes in fatness with age. Physique in all these age groups are very similar. From the groups of gymnasts only the 16 years and older are close to their age-expected physique, though they are still slightly less fat.

Discussion

The differences between the samples of somatotypes of Czechoslovakian and Canadian rhythmic sportive gymnasts described above don't seem to be caused by national/ethnic differences. This was well demonstrated by comparison of both groups of the university students. Although there were some age trends, the differences don't seem to be greatly age related. Therefore, the suggestion is that sport specific demands are a major cause of the differences between both investigated groups. The sport specific differences identified in this study were premature age of gymnasts, decreased muscularity and emphases on linearity and low adiposity.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 August, 1991.

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Anthrop. Közl. *33;* 255–261. (1991)

RELATIONSHIP BETWEEN INDICES OF SEXUAL MATURATION AND PHYSICAL PERFORMANCE

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Abstract: *Rural children (568 boys and 771 girls) aged between 9 and 14.5 years were studied. Maturation was assessed on the basis of breast development in the girls and genital development in the boys according to Tanner. The level of physical fitness was estimated by the motor tests of grip strength, standing long jump and 60 m running time. The children were subdivided into four groups by the stages of their secondary sex characteristics. The performance scores of the respective groups were compared by ANOVA followed by* F-*tests. Performance development was faster in the middle stages in the boys and unexpectedly in the early developmental stages in the girls. Linear correlation with age within the stage subgroups was found only for standing long jump in the boys. In almost every stage subgroup of the girls performance was related to age either linearly or by a second order function.*

Key words: *Secondary sex characteristics; Adolescence; Motor performance.*

Introduction

This paper reports on the motor performance scores of children in the respective stages of sexual maturation. Our approach took account of both the stage of sexual development and chronological age.

The study compared the performance levels of the groups classified by the developmental stage of the breast in the girls and by that of the genitalia in the boys. We were naturally fully aware of the fact that the pubertal development and stages of these characteristics reflected dissimilar ages in the two genders.

Material and Methods

The subjects were a rural and non-athletic subsample of the Jászság study. All of them had begun pubertal development. The calendar age of the girls ranged between 9.0 and 14.5, that of the boys between 10.5 and 14.5 years.

The developmental stages of the secondary sex characteristics were assessed as suggested by Tanner (1962). The subjects' distribution between the respective stages is shown in *Table 1*.

Table 1. **Distribution of the subjects by gender and stages of maturation**

Stage of maturation	2	3	4	5
Boys (568)	227	121	147	73
Girls (771)	161	196	246	168

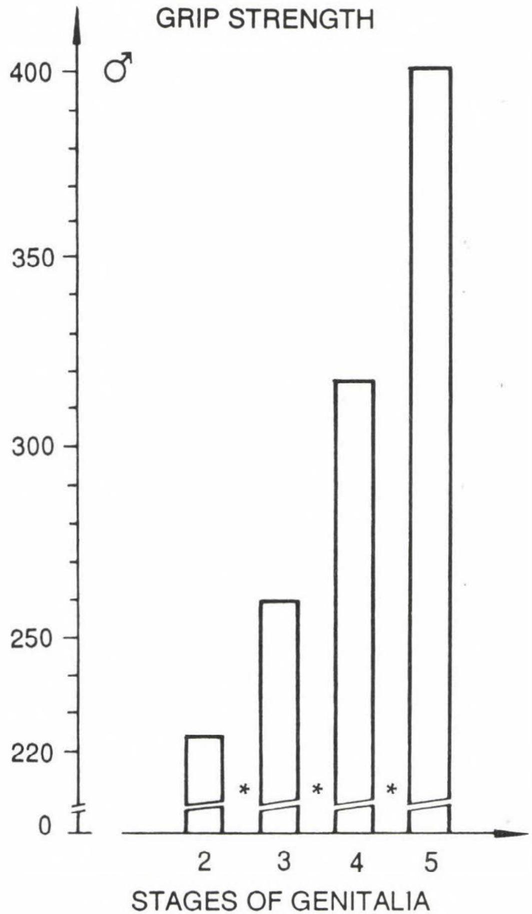

Fig. 1: Mean performance of the boys in grip strength in the respective stages of genital development denoted by numbers below the bars. Asterisks indicate intergroup differences significant at the 5% level

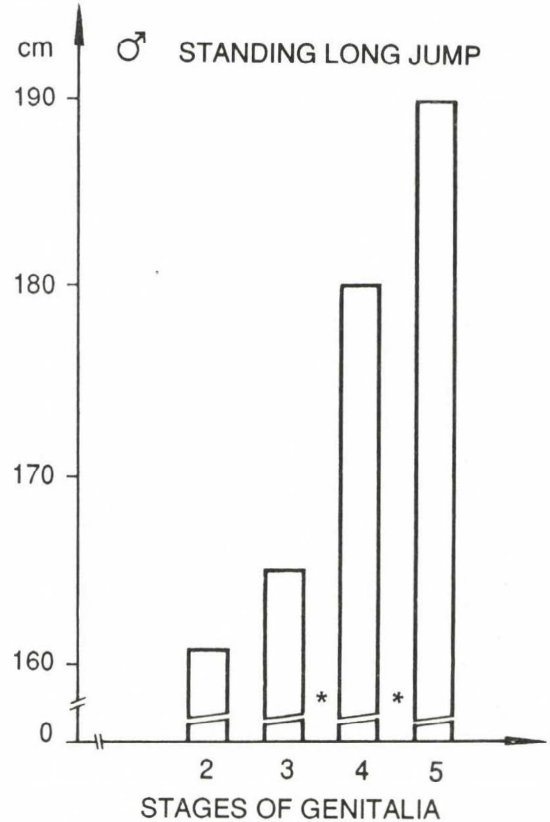

Fig. 2: Mean performance of the boys in standing long jump in the respective stages of genital development. Symbols as in Fig. 1.

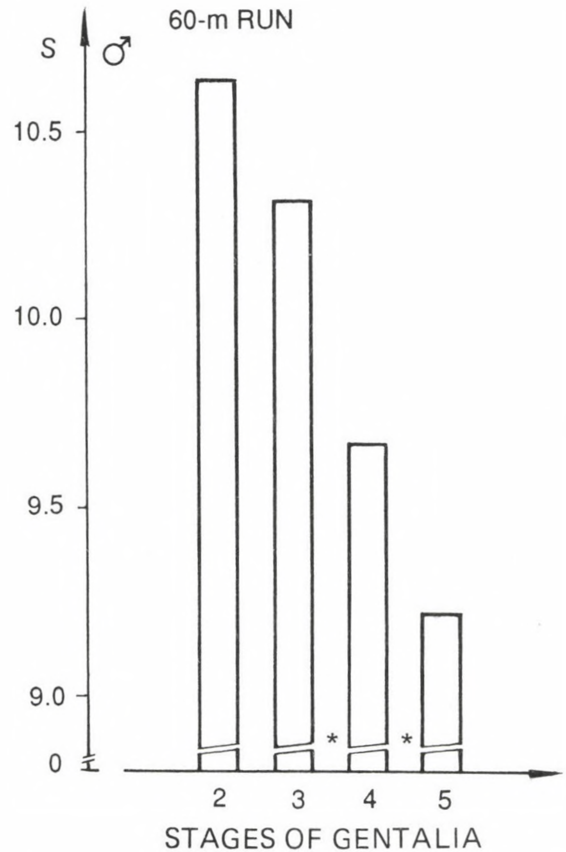

Fig. 3: Mean performance of the boys in 60-m run in the respective stages of genital development. Symbols as in Fig. 1.

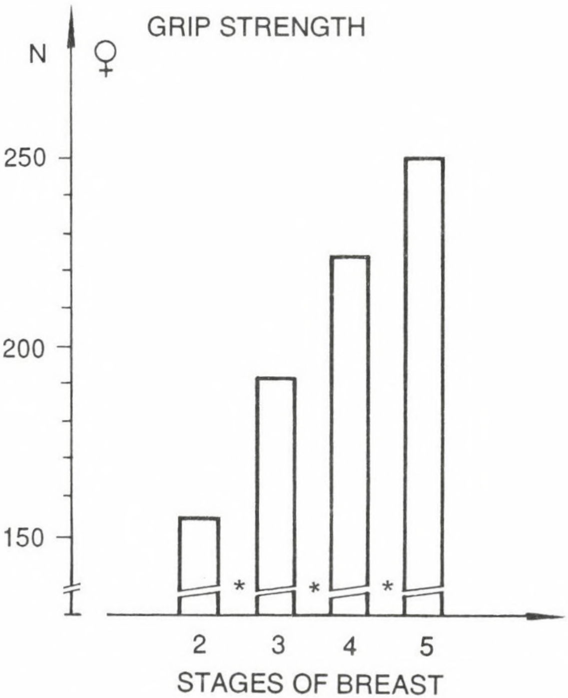

Fig. 4: Mean performance of the girls in grip strength in the respective stages of breast development. Symbols as in Fig. 1.

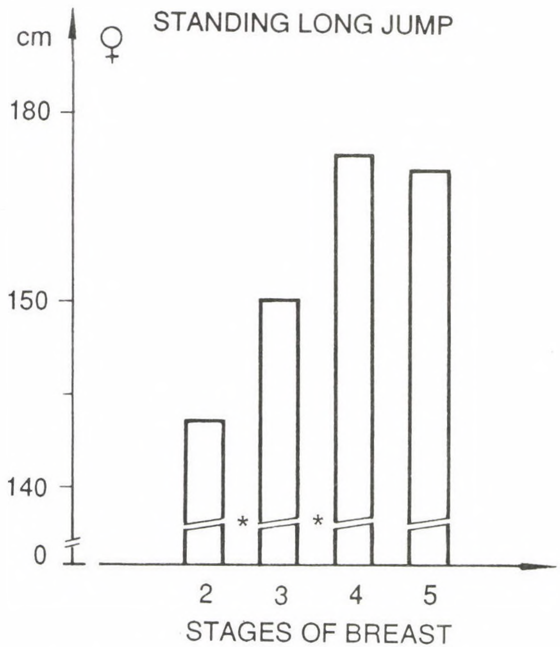

Fig. 5: Mean performance of the girls in standing long jump in the respective stages of breast development. Symbols as in Fig. 1.

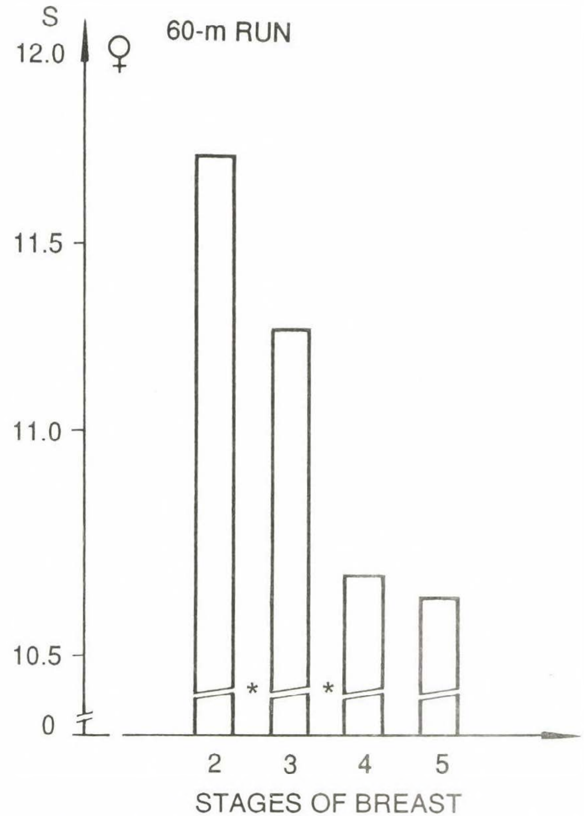

Fig. 6: Mean performance of the girls in 60-m run in the respective stages of breast development. Symbols as in Fig. 1.

Performance was studied in grip strength, standing long jump and 60 m run. After adjusting the handle bars to palm size, grip strength was measured by an electronic dynamometer. The readings were converted to newtons. Standing long jump was measured indoors, along a gymnastic mat, in centimetres. Running times for the 60 m run were measured to the nearest tenth of a second as usual in athletics.

The respective stage subgroups were compared by ANOVA; between-group differences were tested at the 5% level of random error. Multiple comparisons were tested by Scheffé's formula at the 10% level. Regression analysis of trends was used both along the respective stages and along the calendar age groups within the stages.

Results

The first point studied was how performance scores differed between the stages of pubertal development.

In the boys, all stage means for *grip strength* differed significantly (*Fig. 1*). There was no significant difference between stages 2 and 3 for the *standing long jump* (*Fig. 2*), and the *60-m run* (*Fig. 3*),but stages 4 and 5 differed significantly from each other and stage 3 in both.

In the girls, grip strength differed significantly between each stage again (*Fig. 4*). Significant differences for the *standing long jump* (*Fig. 5*) and *60 m run* (*Fig. 6*) were only found between the early stages. Performance did not improve or even deteriorated in the later stages.

The trend lines of the mean performance scores were not linear along the stages, excepting the boys' 60 m run, but all the non-linear regressions were significant.

The second point under study was if children of the same biological developmental stage but of different calendar age differed in their physical performance.

Table 2 summarizes the results of fitting regression lines to the calendar age group means within each stage of sexual development.

Table 2. **Significant linear (1) and second-order (2) relationships between calendar age and motor performance within the respective stages of maturation (0 = not significant)**

Stage of maturation	Boys				Girls			
	2	3	4	5	2	3	4	5
Grip strength	0	0	0	0	1	2	1	0
Standing long jump	0	1	1	0	2	1	1	0
60 m run	0	0	0	0	0	1	2	2

In the boys, only linear relationships were observed and even these were restricted to the standing long jump means.

In the girls, nearly an equal number of linear and second-order trends was found and only three analyses gave a not-significant verdict.

Discussion

The study has evidenced that pubertal changes in physical performance differed for the boys and girls when the subjects were classified by the stages of secondary sex characteristic development. Until now such differences have only been shown for calendar or morphological age in Hungary (Mészáros et al. 1986) and for calendar, skeletal and menarcheal maturity age (reviewed by Malina 1975), but very few studies are available for secondary sex characteristics (Stoev and Rachev 1977). Based on the fact that motor performance in childhood is known to depend markedly on biological age (Szabó and Mészáros 1980, Simons et al. 1978), our working hypothesis was that motor performance would differ across the stages of maturation, but not for children within the same stage, i.e. in the same biological age group.

Strength development in the boys and girls has been reported by Jones (1949), Malina (1975) and Parker et al. (1990) to be very similar in prepuberty but to differ essentially in late adolescence. Jones attributed it to the differential action of sex hormones.

Our data have shown that performance improvement was more marked in the later stages of maturation in the boys, corroborating Bastos and Hegg's report (1986), but in the earlier ones in the girls for which observation we have not found comparable results. Testosterone level in the boys is known to rise steeply from on the 3rd stage and has a direct influence on muscle development. Such effects are absent in the girls (Winter 1978). Thus, some of these change patterns may be attributed to testosterone effects.

In this study motor performance within the respective stages of the boys varied independently of age. Similar observations were reported for boys by Stoev and Rachev (1977). They did not offer any explanation for the phenomenon. Contrary to our expectations, the girls showed various types of age-dependent performance change. The background mechanism for this is not fully clear for us. It may be related to the cross-sectional nature of the study, but one has to reckon with gender-linked dependence on body size as well (Bailey et al. 1978). It is noted, however, that secondary sex characteristics almost reached full development in our girls whereas in the boys this process was yet far from completion. Further research has to take this aspect into account as well.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 2 August, 1991.

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Anthrop. Közl. *33;* 263–266. (1991)

BODY FAT CONTENT AND PHYSICAL WORK CAPACITY OF ADULT SOCCER PLAYERS

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Abstract: *In 64 League I and national team member soccer players' relative body fat content was estimated as suggested by Parizková (1961) while running time in a standard all-out spiroergometric exercise served to assess physical work capacity.*

The group could be regarded as homogeneous on the basis of stature, body mass and weight-related fat content, but variability in running time was nearly twice greater than those in the anthropometric variables.

When the parameters of the national team members were separately analyzed and compared to the remaining subjects, genuine differences only were found in running time (used as an indicator of physical work capacity) and oxygen uptake (used as one of the indicators of aerobic capacity).

Key words: *Body fat content; Soccer players; Oxygen uptake; Running time.*

Introduction

As observed earlier (Mészáros and Mohácsi 1982, Mohácsi and Mészáros 1986), the growth type of adult League I and national team member soccer players differs significantly from that of other Hungarian ball game players, and soccer players are slightly more pyknomorphic than non-athletic young adults (Mészáros and Mohácsi 1987). There is, further, a significant relationship in the soccer players between the indices (metric and plastic index) of the growth type and body-mass-related fat content (Mohácsi and Mészáros 1987).

In respect of physiological work capacity, however, the situation is less simple, because ball game players have been found to have a very similar relative aerobic power (Petrekanits 1986). Thus for instance, random differences only were found between soccer players of the various classes of the national championship (Mohácsi et al. 1990).

The frequency of anthropometric and spiroergometric studies performed in soccer players the last two years allowed us to subdivide our sample. The players that had taken part at least three times in the decisive games of the national team in this period could be separated from those who used to be fix members of the team at the matches of the national championship and Hungarian Cup, i.e. the ones beginning the game.

By comparing the anthropometric and physiological parameters, the aim was to disclose if any difference existed between the two subsamples grouped by so strict criteria.

Material and Methods

The players belonged to five teams of the first league. For the purpose of this study, data of 56 players were selected by the mentioned criteria from among more than 140. The saple consisted of 27 national team members and 29 players who belonged to the first ranking teams of the first league.

Growth types of the subjects were assessed as suggested by Conrad (1963). The metric and plastic indices of the growth type were calculated by using six body dimensions (stature, chest width and depth, biacromial distance and the girths of forearm and hand). In taking body measurements the recommendations of the International Biological Programme (Weiner and Lourie 1969) were observed. Weight-related fat content was estimated as suggested by Parizková (1961), then fat-free mass was calculated.

Physical and physiological work capacity was described by the treadmill running time (s) and during an all-out spiroergometric exercise by the aerobic power related to both total and fat-free body mass. Jaeger model gas analysors and treadmill were used. The subjects warmed up first individually, then after the arrangement of the measuring devices they continued warming up by running at 8 and 10 kmh on the level belt. The test exercise was begun at 12 kmh and 5 degree incline and continued by increasing the belt speed by 2 kmh and the incline by 2 degrees every second minute.

Differences between the respective variable means of thetwo subgroups were analyzed by *t*-tests for independent samples.

Results and Discussion

Means and standard deviations of the variables are shown in *Table 1*.

Stature was statistically not different between the subsamples but was slightly taller than in non-athletic young adults (Mohácsi and Mészáros 1987). First league players were significantly heavier (by nearly 3 kg) than national team members. It is noted that variability in stature was perceivably smalleer and in body mass markedly smaller than in non-athletic young adults (Főnyedi et al. 1988, Gyenis and Till 1981).

Table 1. **Anthropometric and physiological characteristics of the studied soccer players (means ± sd.)**

Variable	National team		League I players		
	x	s	x	s	t
HT	177.76	5.15	178.58	5.22	–
BM	71.15	4.92	74.03	4.76	2.23
F%	8.88	2.85	12.64	3.05	4.76
MIX	−1.09	0.28	−0.75	0.26	4.71
PLX	87.12	2.24	88.48	2.61	–
RT	381.00	35.74	345.52	38.56	3.56
RVO_2	59.06	4.67	52.84	4.33	5.17
LBM	64.83	4.27	64.67	3.78	–
VO_2/LBM	64.82	3.85	60.49	3.01	2.38
n	27		29		

Abbreviations: HT = height cm; BM = body mass kg; F% = relative body fat; MIX = metric index cm; PLX = plastic index cm; RT = running time seconds; RVO_2 = relative aerobic power ml . min^{-1} . kg^{-1}; VO_2/LBM = aerobic popwer related to lean body mass ml . min^{-1} . kg^{-1}; n = subject number

Also relative body fat was lower in the national team members. In view of body mass, first league players were likely to differ merely by having larger fat stores. When r ieans only are analyzed, this amount of fat is unlikely to affect physical and physiological work capacity. By taking account of variability, however, some of the first league players might be even regarded as obese, particularly in view of their age, growth type linearity and quality of physical activity.

Thegrowth type indicees showed the first leaguer subgroup to be slightly pyknomorphic normoplastic individuals while national team members were normoplastic metromorphs.

The observed functional indicators showed national team members to be in a distinctly better shape. They ran 36 seconds longer and had 6 ml larger relative aerobic power. Since first leaguers were significantly heavier, the latter statement might seem trivial. Nevertheless, aerobic power in the national team members was also greater when related to fat-free mass.

Comparatively, mean relative aerobic power of even national team members could not be considered as excellent; other ball game players used to display a similar aerobic power (Petrekanits 1986), and soccer players of international calibre have usually better figures (Petrekanits 1986, Fekete et al. 1989).

Yet, realizing that relative aerobic power is but one aspect of physiological work capacity, further that connexion between relative aerobic power and event-specific performance is usually loose, even this result contained some intriguing aspects. What factor(s) enabled national team members to run longer? Was this a result of their higher aerobicv power orelse the latter was theresult of more intense exercise? These are difficult questions to answer since relative aerobic power in adult athletes can be but very moderately improved even by one or two years work (Mészáros et al. 1989, 1990).

In interpreting the observed differences we have thought selection effects are more likely to have worked than differences in physical fitness. It is also noted that soccer performance cannot be validly estimated by the indicators used so one has to accept the judgement of the coaches. It is emphasized further that not even athletic condition can be safely assessed by a single study. It was only a momentary state of fitness and a global idea of the players' cardio-respiratory endurance capacity that could be obtained. For the players' preparation, however, even this limited information is of advantage, the more so when one considers that the part training can play in improving the essential base, the athletes' physiological work capacity, is much more restricted than the one in, for instance, event-specific preparation.

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Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 25 July, 1991.

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Anthrop. Közl. *33;* 267–272. (1991)

PHYSICAL STRUCTURE AND PERFORMANCE OF YOUNG SOCCER PLAYERS

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Abstract: *The purpose of this study is to present the results concerning body size, growth, proportionality, body composition and somatotype of 371 young austrian soccer players in relation to their performance. They were compared with non-athletic young males. There have not been found any significant differences in body weight, height and circumferences of the extremities between investigated players and non-athletes. The body composition has been found to correspond to this sports' branch: Body fat is significantly lower and lean body mass is higher. A characteristic body feature of these players is shorter length of the lower limbs. The most favourable somatotype with following component 2–5–3 is situated in the ectomorphic mesomorph category. According to the Somatotype Dispersion Index the young soccer players are classified as a hetgerogeneous group. Approximatively two thirds of all players dispose of the advantageous somatotypes correlating to the best performance.*

Key words: *Body dimensions; Body composition; Somatotype; Performance; Soccer players.*

Introduction

The aim of this project was to study some of the anthropometric variables and the level of physical capacities of young soccer players. The knowledge of our analysis should help during selection of the adept for this sports speciality. On the other hand conclusions concerning performance parameters can positively influence training process of investigated probands.

Material and Methods

In 1990 the number of 371 players ranging from 13 to 19 years of age, participants of Young Soccer League who are the members of 14 Austrian Sports Centers were tested.

With the help of standardized measurement techniques (Martin/Saller 1957) the following body dimensions and indices were obtained:

Basic Parameters: Body mass (kg), Body height (cm); *Body Composition:* Body fat (%), Lean body mass (kg); *Circumferences:* Upper arm girth flexed (cm), Thigh girth gluteal (cm), Calf girth maximum (cm); *Body indices:* Quetelet-Bouchard's Index, and Manouvrier's Index.

The body type was estimated according to the Heath/Carter method (1967). The homogenity, respectively heterogenity of each age group was determined with the help of the Somatotype Dispersion Index (SDI) according to Ross/Wilson (1973).

All collected data were statisticly calculated. A part of measurements, carried out at the occasion of the Czechoslovak Spartakiade 1985 (Blaha 1985) has been used as material for comparison . The following physical capacities were tested: *Speed/Capacity to accelerate:* 10 m, 20 m Sprint (sec); *Elastic Strength:* Standing Long Jump (m); *Speed-Endurance:* 180 m Shuttle Run (sec, mmol); *Aerobic Endurance:* 2x2000 m (m/sec); *Flexibility:* Trunk Flexion (cm), and Leg Split (degree°).

Results and Discussion

Anthropometric variables and indices

In general no significant differences in body weight and height between Austrian socces players and non-athletes have been found (*Fig. 1, 2*). The relationship between body weight and height of foregoing conclusions expressed by Quetelet-Bouchard's index has ascendent tendency with the factor of age. Young Austrian soccer players aren't significantly heavier than normal population.

Body composition results respond to the requirements of this sports' branch. Except of the group aged 16 the percentual part of body fat (9%–11%) is significantly lower in comparison to the non-athletic sample. On the other hand lean body mass of each age group is generally significantly higher.

To express body proportionality the Manouvrier's index has been used, which informs us about the proportionality of the length of upper and lower body segment. The level of this index has a descending tendency during observed period of growth and development. A relatively shorter length of lower extremities in comparison to non-athletes is a very important body feature of young soccer players.

The circumferences of the extremities, upper arm girth flexed, thigh girth gluteal and calf girth maximum are not significantly different from a normal population. Upper arm girth flexed is a little bit smaller, but thigh girth gluteal is a little larger. Calf girth maximum corresponds to the norm. According to the above results the young soccer players could be classified as light displastic types, because of their unequal muscle distribution.

Somatotyp

From a somatotype point of view the investigated sample is evaluated as heterogeneous. The most heterogeneous group from all age groups has been found in players aged 13. The heterogenity of these players correlates to a large variability of body parameters, typical for a period of puberty. On the other hand the most homogeneous group were boys aged 16.

The mean somatotype 2–5–3 is situated in the ectomorphic mesomorph category (*Fig. 3*). Almost 65% of all boys belong to the most advantageous performance area of somatochart which predicts the best performance. An optimum level of three somatotype components correlated to the performance is following: Endomorphy 1.5 – 2.5; Mesomorphy 4.5 – 5.5; Ectomorphy 2.5 – 3.5.

In spite of the fact that 2/3 of all young soccer players dispose of a relative good level of somatic dimensions, there are almost 35% of players with no-answering body features for this sport. That means that responsible persons for selection should set more importance to the somatic side of the adepts in this sport.

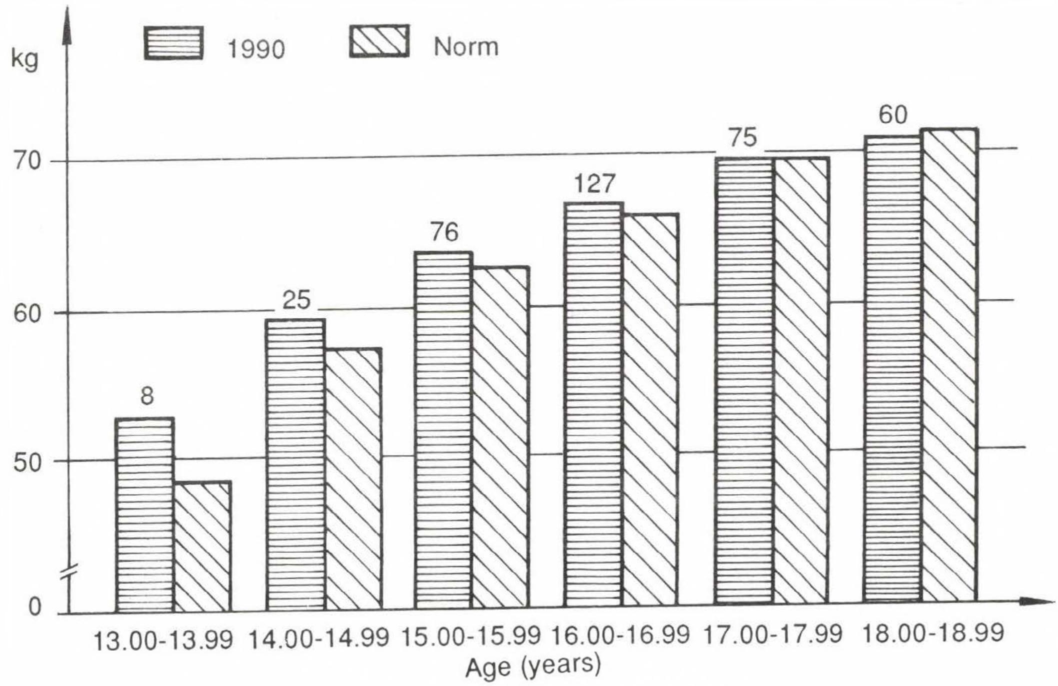

Fig. 1: Body mass of young Austrian soccer players.
1990 = Soccer Players investigated in 1990; Norm = Non-athletes

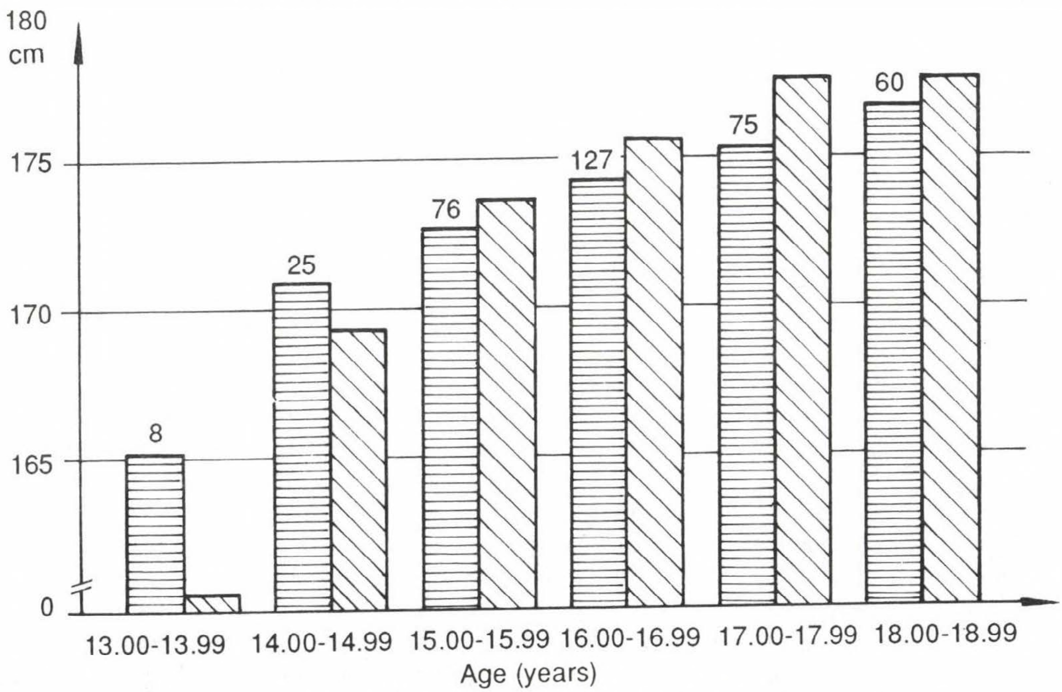

Fig. 2: Body height of young Austrian soccer players.
1990 = Soccer Players investigated in 1990; Norm = Non-athletes

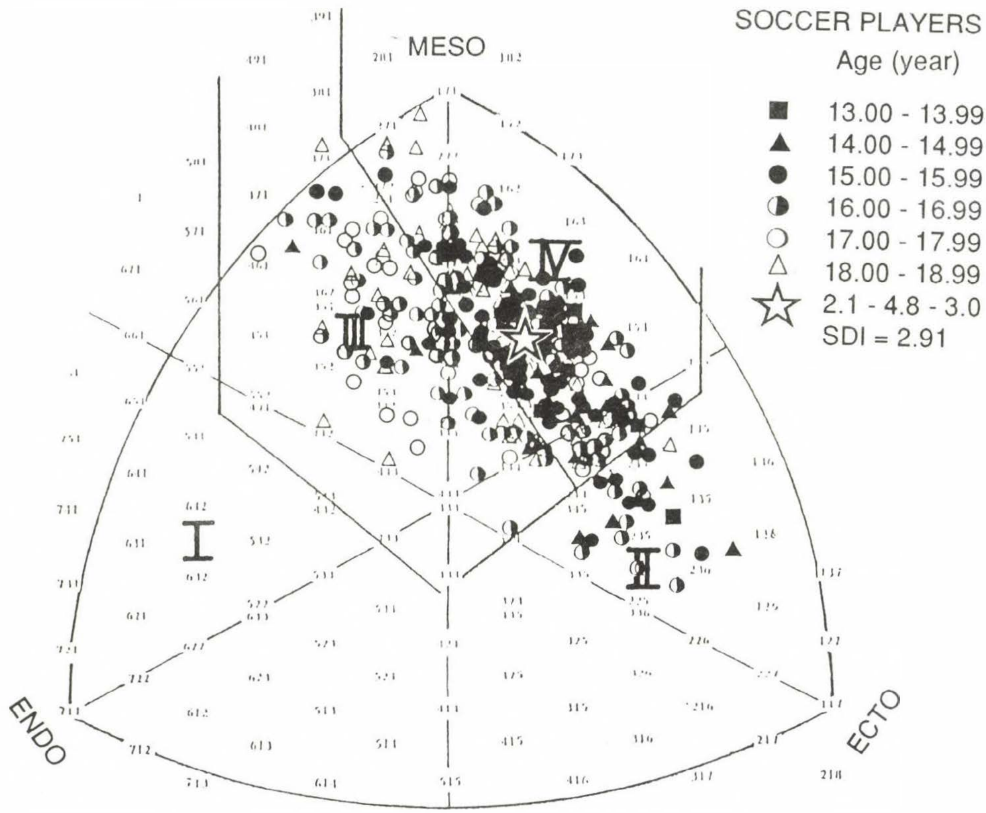

Fig. 3: Somatotypes of young Austrian soccer players.
☆ = Mean Somatotyxpe of Total Group; SDI = Somatotype Dispersion Index

Physical capacities

To evaluate the physical capacities the norm values of the specific group were used. The results of the 10 m sprint test of our investigated players are under the norm. In comparison to the 10 m sprint test the results of the 20 m sprint test are poor. This seems to be caused by an insufficient level of coordination, especially inadequate development of running technique. Identical results were found in elastic strength (Standing Long Jump), too. A reason for the low level of physical capacity could be an inadequat strength. The speed-endurance is at a very good level but the aerobic endurance is only at an average level. The flexibility tests showed a clear deficiency in this field. That means in particular that gymnastic elements during training are not present sufficiently.

The technical and tactical abilities of our players were evaluated by a questionnairy completed by responsible coaches. *Fig. 4* shows differences in all the tested performance parameters among the 10 best and the 10 weakest young soccer players. These results have exposed a coincidence between the level of physical capacities and a high score in the questionnairy. The best players according to the coaches have obtained the best results in sports tests.

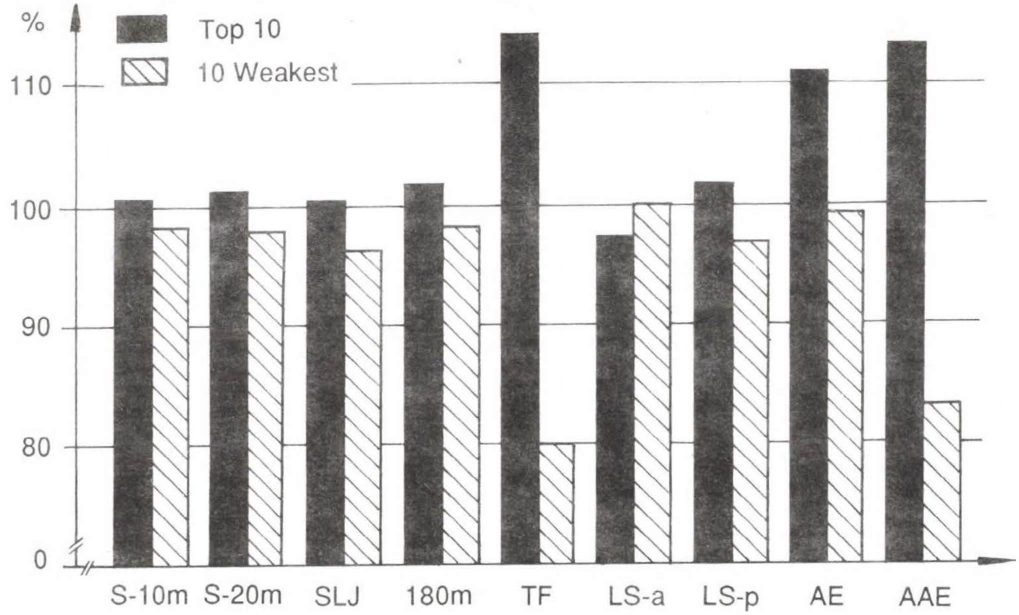

Fig. 4: Comparison of the top 10 and the 10 weakest players (judged by the coaches): Physical capacities, in percent of the total average. S–10 m = 10 m Sprint; S–20 m = 20 m Sprint; SLJ = Standing Long Jump; 180 m = 180 m Shuttle Run; TF = Trunk Flexion; LS–a = Leg Split active; LS–p = Leg Split passive; AE = Aerobic Endurance; AAE = Anaerobic Endurance; Top 10 = the 10 Best Players; 10 Weakest = the 10 Weakest Players

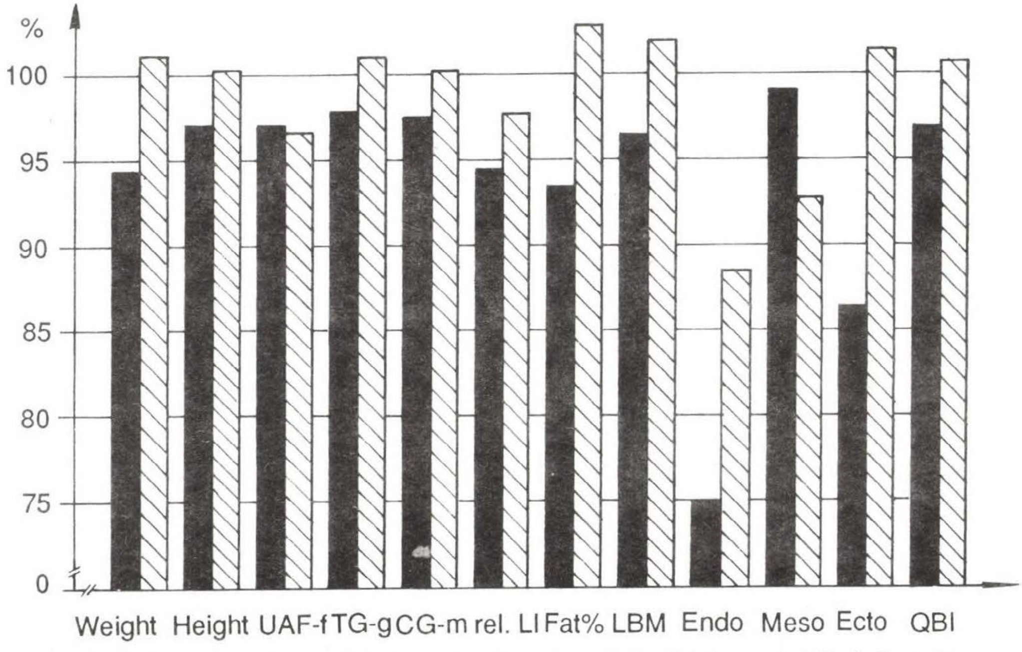

Fig. 5: Comparison of the top 10 and the 10 weakest players (judged by the coaches): Body dimensions, indices and somatotype, in percent of Norm (age 16.00–16.99 year). Weight = Body Mass, Height = Body Height, UAG–f. = Upper Arm Girth flexed; TG–g. = Thigh Girth gluteal; CG–m. = Calf Girth maximum; rel.LL = relative Length of Lower Limbs; Fat% = Body Fat in %; LBM = Lean Body Mass; Endo = Endomorph Component; Meso = Mesomorph Component; Ecto = Ectomorph Component; QBI = Quetelet-Bouchard's Index; Top 10 = the 10 Best Players; 10 Weakest = the 10 Weakest Players

What are the differences between the best and the weakest players?

Fig. 5 shows that the best players are significantly smaller but not lighter in comparison to the weakest players and the norm sample, too. They dispose of a significantly lower part of body fat, but mesomorphy of the best players is at a higher level. There are no differences in upper arm girth flexed, but circumferences of lower extremities are weaker in the best group. A deficiency of muscles is given by a lower level of body mass. There is an evident difference in body proportionality. The best players dispose of a significantly shorter length of their lower segment. That means their center of gravity is located a little bit lower in comparison to the weakest players and non-athletes. This could be the reason for the better mobility and speed of the best players. Nevertheless the lower level of body fat plays a very important role, too. As far as the length of lower extremities is concerned those of the best players are classified as "middle long", those of the weakest players as "long".

Conclusions

What about a somatic model of a successful young soccer player?

The successful young soccer player should dispose of the following somatic features:

- average body weight and middle growth
- lower level of body fat, about 10%
- solid level of lean body mass in comparison to body height
- somatotype 2–5–3 situated in the ectomorphic mesomorph category of somatochart
- relatively shorter length of lower extremities in comparison to non-athletes

*

Paper presented at the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. *33*; 273–281. (1991)

HEREDITY – ENVIRONMENT INFLUENCES, ON GROWTH AND MATURATION DURING PUBERTY

A CROSS-CULTURAL COMPARISON

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Abstract: *In a Swedish longitudinal project (SLU) a model has been developed presenting hypothetic within-pair similarity for MZ and DZ twins for different types of characteristics and environments.*

Two main results were found: The influence of hereditary and environmental factors will vary for different characteristics. – The influence of hereditarty and environmental factors will vary for the same characteristic depending upon differing environmental impact.

To further explore the importance of environmental variation a cross-cultural comparison is presented. Height and weight growth for MZ and DZ twins in Poland and India has been related to height and weight growth for Swedish twins. Within pair similarity for MZ and DZ twins in physical growth seems to be fairly similar for Sweden and Poland, while data from India partly show a different trend.

These results are discussed in relation to the model and environmental differences between countries.

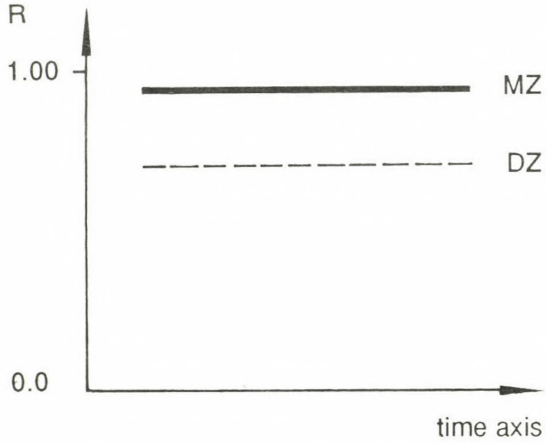
Key words: *Growth and maturation; Twins; Model of nature-nurture contribution; Swedish, Polish and Indian boys and girls.*

Introduction

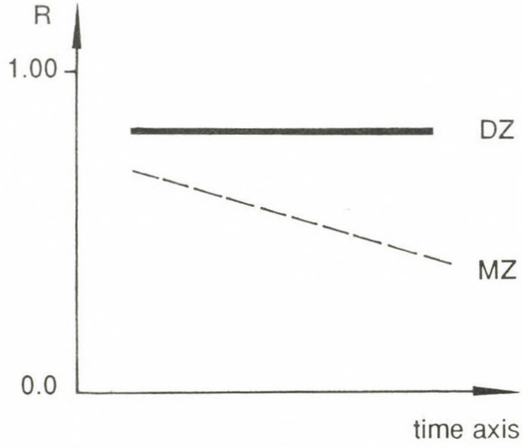
One way of studying heredity-environment influences on physical growth is to make a comparison of within-pair similarity for monozygotic (MZ) and dizygotic (DZ) twins. The twins are used as a *method* for separating genetic and environmental variation when looking at, for instance, height and weight growth during puberty. This can be done since MZ twins are genetically identical, while DZ twins have 50 percent of their genes in common, on average. The more similar the MZ twins are in comparison to the DZ twins, the greater the probability of genetic factors influencing the variation of the characteristic studied. This is a simplification, however, since the difference in within-pair similarity for MZ and DZ twins is often due also to an interactional effect. MZ twins tend to react to and be treated similarly by individuals in their environment, while DZ twins react to and are treated differently by these persons. Such dynamic interactional influences can be studied by means of longitudinal twin data.

Model of nature-nurture contribution

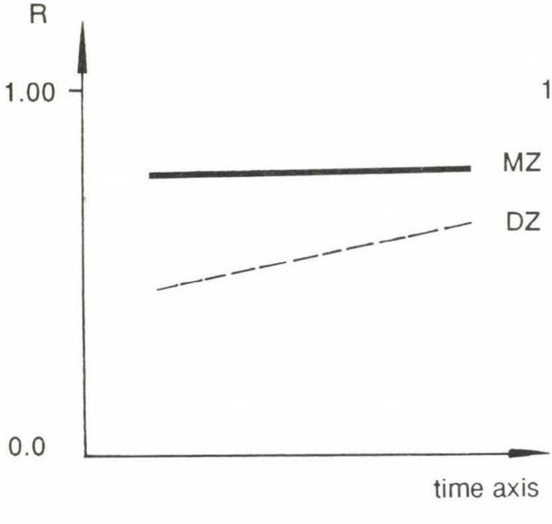
In a Swedish longitudinal twin project a model was developed presenting hypothetic within-pair similarity for MZ and DZ twins for different types of characteristics and for different types of environments. Intra-class correlations (R) have been used to illustrate within-pair similarity. This model is shown in *Figure 1.*



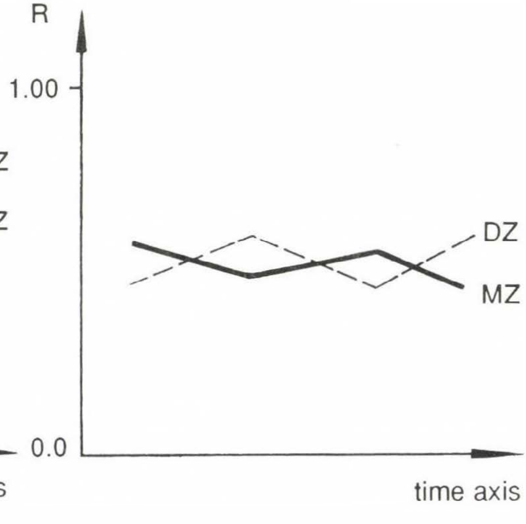
a) Constant and additive environmental effects



b) Divergence hypothesis. Interactional and correlational effects (permissive environment)



c) Convergence hypothesis (restrictive environment)



d) A variable primarily controlled by environmental factors

Fig. 1: Hypothetical intra-class correlations for MZ and DZ twins assuming similar environments, and varying nature-nurture contribution

Example a) Illustrates development of a characteristic primarily controlled by genetic factors, where environmental effects are assumed to be *constant* and *additive*. MZ twins, due to their identical inheritance, tend to be more similar than DZ twins and this diffe ence tends to be of the same magnitude as long as the twins are exposed to the same environmental impact. No lowering of the intra-class correlations with increasing age is hypothesized.

Example b) illustrates a *divergence* hypothesis proposed by Fuller & Thompson (1961). Under permissive circumstances MZ twins react similarly to the same environmental influences, while DZ twins react differently and thus get progressively less similar. A lowering of the intra-class correlations for DZ twins but not for MZ with increasing age is hypothesized.

Example c) illustrates a *convergence* hypothesis also suggested by Fuller & Thompson (1961). Due to restrictive environmental influences negatively reinforcing genetic differences, DZ twins will get progressively more similar with increasing age. The intra-class correlations for DZ twins will thus be higher with increasing age and remain constant for MZ twins.

Example d) illustrates *unsystematic environmental effects* largely counteracting genetic differences. Since the identical inheritance of MZ twins does not predispose them for greater similarity, it will be incidental if the intra-class correlations for MZ twins will be higher than for DZ twins.

Of course this model is not static, but the results will vary with the populations studied and the cultural environment involved. What is classified in one society as a characteristic under a) might for instance be susceptible to interactional effects as in example b) in different environmental circumstances. Assuming comparable (similar degree of genetic regulation) variables, constitutional factors will be of relatively minor importance in a restrictive environment and of greater importance in a permissive environment.

This model thus presupposes that interactional effects will vary for different characteristics and for different environmental circumstances and it is therefore of special interest to apply it to the same type of data collected in different countries. In the following this model has been used to illustrate within-pair similarity in physical growth and maturity during puberty for MZ and DZ twins from three different countries with varying demographic, cultural and economic backgrounds, namely Sweden, Poland and India. It is hypothesized that height growth and physical maturity will be more genetically regulated than weight growth irrespective of cultural differences and that weight growth is more susceptible to interactional effects in all three countries (Fischbein 1979).

Material and Methods

In *Sweden* 323 twin pairs were followed as part of a larger project from 10 years of age to 16 years of age for the females and 18 years of age for the males. Of the twin pairs there were 94 MZ pairs, 133 like-sexed DZ pairs and 97 unlike-sexed pairs. For classifying the like-sexed twin pairs a morphological diagnosis according to a special schedule was applied. Erroneously judged cases can be estimated as not more than 10 percent with this type of similarit diagnosis (Husén 1959, Cederlöf et al. 1961). The reliability of this method can therefore be considered sufficiently accurate for group comparisons, if the groups are not too small. A thorough serological analysis has been carried out at the Karolinska Institute in Stockholm, for 71 pairs of the 133 like-sexed twin pairs. Out of these, only 3 pairs or 4 percent, had been erroneously diagnosed as MZ instead of DZ, and have thus been reclassified. The project was called the SLU-study. Height and weight growth was measured by the school nurses every half year and adjusted to the childrens' chronological age. The methods used in the SLU-project for estimating the age at which different criteria of physical maturity were reached are age at peak height velocity (PHV) and peak weight velocity (PWV) according to a modified "mid-year-velocity" method. Individual height and weight measurements were adjusted to specific chronological ages. The yearly increments were then calculated for each 6 months. The midpoint of the 12 months interval during which the maximum yearly increment occured was taken as age at PHV or PWV (Fischbein 1977a). In addition to this, ratings were made of the development of secondary sex characteristics in both the male and female twins. Menarche for the girls was also registered (Ljung et al. 1977).

In *Poland* the Wroclaw Longitudinal Twin Study consisted of 296 pairs (149 MZ and 147 DZ). Of these 195 pairs were examined in 1972. The second part of the material is including 101 pairs examined in the years 1959–1961. Zygosity diagnosis for the twins is based on three independent tests: (1) The polysymptomatic diagnosis of similarities, including different morphological traits; (2) The discriminant function, based on a complex similarity of 64 dermatoglyphic traits; (3) The analysis of blood groups concordance with calculation of monozygosity probability by means of the method of Maynard–Smith & Penrose (1955), on the basis of pD values elaborated for the Polish population. The analysis of results obtained by means of the three mentioned methods has shown that only in 5 cases per 220 twin pairs or 2.3 per cent, diagnostic difficulties, caused by various reasons, appeared (Orczykowska–Swiatkowska 1988). Anthropometric measurements as well as physiological and psychological information were collected annually by the same staff, using the same instruments. A full description of the project is given by Bergman & Orczykowska–Swiatkowska (1976).

In *India* 48 pairs of MZ and DZ like-sexed pairs were measured as part of a larger project. Height and weight measurements as well as observations of secondary sex characteristics were recorded at three-monthly intervals from 10 to 18 years of age. To estimate ages at peak height and peak weight velocities (PHV and PWV), the velocity curves of the measurements were plotted separately for each individual and the age at which the maximum velocity was reached on the graph was recorded as the age at peak velocity. The number of twins varies at different ages, since not all twin pairs were available for observations at each stage repeatedly. The subjects belonged to upper-middle class Khattris of Chandigarh city and were well fed by Indian standards. Only physically normal twins who had never suffered from any major ailment and were unmarried were included in the study. Zygosity was established on the basis of ABO, MN, Rh blood groups, ABH secretion and PTC-testing ability as well as various morphological characters (Sharma 1983).

Results

Height

For a study of concordance for MZ pairs in comparison to DZ during puberty, within-pair correlations (intra-class correlations) for height by age have been estimated. This has been done for data from the three different countries and is presented in *Table 1* and further illustrated in *Figure 2*.

Table 1. **Intra-class correlations (R) for height in male and female MZ and DZ twins from 10 to 18 years of age. Data from Sweden (Fischbein 1977b), Poland (Bergman 1988, 1989), and India (Sharma 1983)**

Age (year)	Sweden				Poland				India			
	MZ		DZ		MZ		DZ		MZ		DZ	
	M	F	M	F	M	F	M	F	M	F	M	F
10	.95	.97	.72	.52	.94	.93	.71	.43	.90	.92	.68	.70
11	.96	.96	.68	.68	.95	.92	.72	.46	.92	.93	.58	.65
12	.96	.94	.69	.66	.95	.93	.68	.50	.89	.90	.46	.56
13	.97	.93	.66	.64	.96	.93	.65	.56	.92	.90	.44	.52
14	.96	.94	.65	.67	.96	.94	.66	.54	.90	.88	.50	.54
15	.95	.91	.63	.73	.96	.94	.72	.49	.87	.87	.52	.51
16	.95	.93	.68	.54	.96	.94	.75	.45	.88	.91	.56	.51
17	.91	–	.74	–	.95	.94	.77	.50	.89	–	.62	–
18	.94	–	.74	–	.96	.91	.80	.40	.88	–	.58	–

For both male (M) and female (F) twins the intraclass correlation coefficients tend to be very high (around .90) in all three countries. In India the correlations seem to be somewhat lower than in Sweden and Poland and sometimes drop below .90. They are, however, stable over time and there is no sign of a decreasing within-pair similarity by age.

The DZ correlations tend to be lower but we can also see a sex difference in Sweden and Poland, which is not evident in India. In the first-mentioned countries the male correlations are fairly high (around .70) during puberty, while the female correlations tend to be somewhat lower (around .50–.60). This trend seems to be the same in both Sweden and Poland even if the female correlations tend to be a little lower in Poland. In India, on the other hand, the intra-class correlations seem to be of the same magnitude (around .50–.60) irrespective of sex. We can also see from *Figure 2* that, generally, the MZ correlations are very stable over time in all these countries even if they tend to be a little lower for the Indian twins. The DZ correlations, on the other hand, fluctuate much more in all three countries, which is at least partly a reflection of the variation in the onset of growth spurt in the DZ twins.

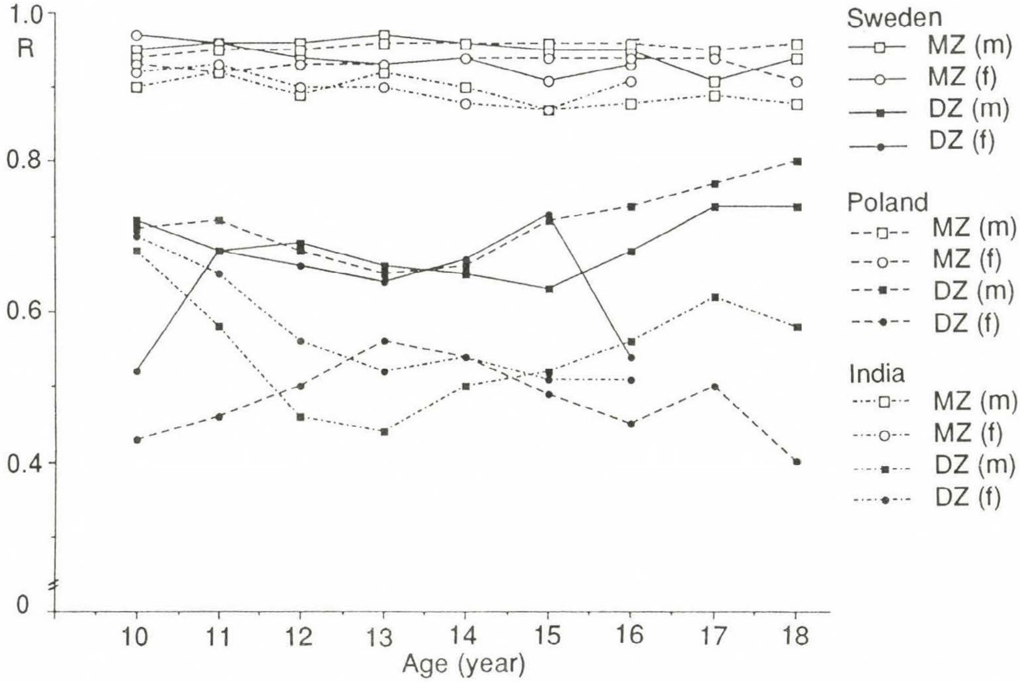


Fig. 2: Intra-class correlations for height from 10 to 18 years of age for male and female MZ and DZ twins

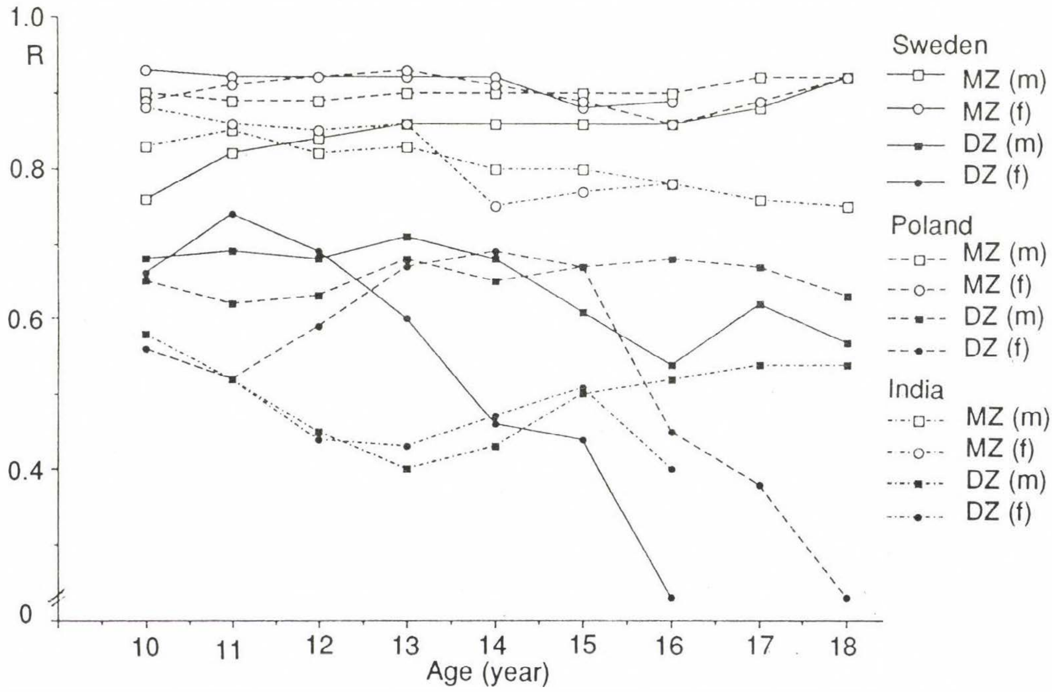


Fig. 3: Intra-class correlations for weight from 10 to 18 years of age for male and female MZ and DZ twins

Table 2. **Intra-class correlations (R) for weight in male and female MZ and DZ twins from 10 to 18 years of age. Data from Sweden (Fischbein 1977b), Poland (Bergman 1988, 1989), and India (Sharma 1983)**

Age (year)	Sweden				Poland				India			
	MZ		DZ		MZ		DZ		MZ		DZ	
	M	F	M	F	M	F	M	F	M	F	M	F
10	.76	.93	.68	.66	.90	.89	.65	.56	.83	.88	.58	.56
11	.82	.92	.69	.74	.89	.91	.62	.52	.85	.86	.52	.52
12	.84	.92	.68	.69	.89	.92	.63	.59	.82	.85	.45	.44
13	.86	.92	.71	.60	.90	.93	.68	.67	.83	.86	.40	.43
14	.86	.92	.68	.46	.90	.91	.65	.69	.80	.75	.43	.47
15	.86	.88	.61	.44	.90	.89	.67	.67	.80	.77	.50	.51
16	.86	.89	.54	.23	.90	.86	.68	.45	.78	.78	.52	.40
17	.88	–	.62	–	.92	.89	.67	.38	.76	–	.54	–
18	.92	–	.57	–	.92	.92	.63	.23	.75	–	.54	–

Weight

In *Table 2* and *Figure 3* intra-class correlations for weight during puberty in the three countries are presented.

Also for weight the MZ correlations are very high during puberty for both male (M) and female (F) twins in all the three countries (around .80–.90). The DZ twins show a remarkable sex difference in both Sweden and Poland. Male DZ twins are fairly similar in weight during the whole growth period, while female DZ twins tend to become less similar. At 16 and 18 years of age respectively, the dizygotic twin girls show a correlation of .23, which is much lower than would be expected if only genetic influences were operating.

In India this sex difference seems to be less conspicuous for both height and weight growth. MZ correlations for weight seem to drop, however, for both boys and girls after puberty, which might be an indication of a larger influence from environmental factors.

Onset of puberty

To study onset of puberty in boys and girls the ages of peak height or peak weight velocity (PHV and PWV) can be compared. For girls age at menarche can also be used as a measure of physical maturity. *Table 3* presents intra-class correlations for age at PHV and PWV for male and female MZ och DZ twins as well as age at menarche for female MZ and DZ twins in Sweden, Poland and India.

The MZ correlations are higher than the DZ correlations for all measures of physical maturity in all the three countries. The highest correlations are found for MZ twins for age at menarche (around .95). The intra-class correlations for measures of physical maturity general tend to be of the same magnitude for both MZ and DZ twins in Sweden, Poland and India which might be due to the fact that these samples are living in fairly good environmental circumstances.

Table 3. **Intra-class correlations (R) for age at PHV and PWV for male and female MZ and DZ twins as well as for age at menarche for female MZ and DZ twins. Data from Sweden (Fischbein 1977a,b), Poland (Bergman 1988, 1989), and India (Sharma 1983)**

Measures of physical maturity	**Sweden**				**Poland**				**India**			
	MZ		**DZ**		**MZ**		**DZ**		**MZ**		**DZ**	
	M	F	M	F	M	F	M	F	M	F	M	F
Age at PHV	.85	.78	.42	.39	.93	.87	.57	.59	.98	.95	.36	.58
Age at PWV	.68	.83	.38	.50	.87	.81	.42	.59	.75	.85	.30	.42
Age at menarche	–	.93	–	.62	–	.95	–	.61	–	.97	–	.50

Summarizing the results concerning intra-pair similarity in physical growth data during puberty for MZ and DZ twins in Sweden, Poland and India, the main conclusion is that differences between countries are not very large and conspicuous. The sex differences with lower female DZ correlations found after puberty for both height and weight growth in Sweden and Poland does not seem to be present in the Indian sample. In all these countries, MZ correlations seem to be fairly high and stable over time. There can be seen, however, a trend for decreasing MZ correlations in the Indian sample particularly for weight growth, which is not evident in the other two countries.

Discussion

Within-pair similarity in physical growth for MZ and DZ twins during puberty has been compared for three different countries, Sweden, Poland and India. This is done with reference to a model illustrating nature-nurture interaction in longitudinal twin data. It is hypothesized that height growth and physical maturity will be more genetically regulated than weight growth irrespective of cultural differences. Weight growth, on the other hand, will be more susceptible to interactional effects, which might influence within-pair similarity for MZ and DZ twins differently in the three countries, depending upon cultural variations.

The twin samples were all longitudinal and living in fairly good environmental conditions. The results indicate that *height growth* generally follows a trend compatible with example *a)* in the model. Within-pair correlations for MZ twins are consistently high during the whole pubertal period. Data from the Indian twins show somewhat lower correlations but no increasing or decreasing trend. DZ correlations fluctuate much more, due to variations in age at PHV for the twins in a pair. There is, however, no consistent increasing or decreasing trend for DZ correlations in height growth during this period. Within-pair similarity in physical maturity also seems to be high for the MZ twins and moderate for the DZ twins. These data thus indicate a primarily genetic regulation of height growth and physical maturity in the three countries.

Weight growth, on the other hand, shows the same trend in Sweden and Poland with high intra-pair correlation coefficients for MZ twins and decreasing DZ correlations, particularly for the female twins. This trend is in accordance with example *b)* in the m del and seems to imply larger interactional effects for girls than for boys in weight growth during puberty. This sex difference is, however, not evident in the Indian sample. The MZ Indian twins also show somewhat decreasing within-pair similarity during the pubertal period, which indicates a converging trend compatible with example *c)* instead of a diverging trend as in example *b).* A possible explanation of these results might be that nature-nurture interactional effects on weight growth in the Indian society are mainly of a restrictive character for both boys and girls, while a permissive situation is Sweden and Poland gives more room for individual regulation. This might be especially evident for the girls due to weight being a more sensitive characteristic, where beauty ideals and dieting is more linked to body image and weight growth for girls than for boys.

Paper sent to the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 1 October, 1991.

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Acknowledgement: I want to thank Drs Bergman and Sharma for giving me access to their valuable data materials. This has been a necessary prerequisite for writing this article.

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Anthrop. Közl. *33;* 283–289. (1991)

ALTITUDE AND GROWTH AMONG VENEZUELAN SCHOOLDCHILDREN OF THE ANDEAN REGION

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Abstracts: *The results of a cross-sectional growth study of Venezuelan schoolchildren of both sexes (n = 3020) from high and low altitude areas in the Andean region are presented. The study reveals no statistical significance in body dimensions in altitude (130–3200 m) neither urban or rural condition at the end of growth (18 yr), however, there were differences when compared between ages. Nutritional patterns were different between high and low altitude populations, but the total calories intake were deficient in both cases. Cormic index was 52 between 8 to 16 yrs. shown our poliethnic origin. We concluded that enviromental (nutrition) and genetic factors seems to be responsible for growth variation observed in high altitude and low altitude children in a higher degree than does hypoxia.*

Key words: *Growth and development; Altitude; Nutrition; Hypoxia.*

Introduction

Children's growth varied between countries to another and even in the same country or area (Eveleth and Tanner 1976). It is influenced by genetic, endocrine and enviromental factors which characterize individual phenotype. Many studies have been published to shown altitude impact on men in the Andes, West Africa and India, only a very few studies are known on Venezuela and even fewer in the Andean region (Pereira 1988). Frisancho (1969) postulated the developmental adaptation hypothesis (DAH) on the basis of data collected on Quechua highlanders from Nuñoa, Peru (Frisancho 1969, 1976, Frisancho and Baker 1970), propose that the supply of metabolic energy which can be utilized for body maintenance and growth is limited by the availability of oxygen, assuming that the metabolic energy required for optimal musculoskeletal growth is not available for highland children. The state of Merida presents the widest variation in altitude of the whole country: from 5 to 3500 m under sea level. It is the object of this paper to characterize growth of Venezuelan children living at high altitudes and test the predictions of DAH for other Andean regions.

Material and Methods

In a cross-sectional growth study of 3020 Andean children (1460 boys and 1560 girls) aged 6 to 18 years 21 anthropometric measurements were made by the author according to IBP suggestions (Weiner and Lourie 1969). In this paper we present height, weight, sitting height, subischial lenght, biacromial and biiliac diameters. Haemoglobin and haematocrit determinations were done as well as a nutritional survey firstly using the 24 hour recall method and secondly the method of weighing the food. Data of children and adolescents living at 130 meters (El Vigia) using a *t*-test were contrasted to those living at 3200 meters (San Rafael de Mucuchies).

Results

Children from El Vigia (low altitude) and San Rafael de Mucuchies (high altitude) in all ages show a *height* below the 50th centile of the Merida reference (Pereira 1980) except boys from high altitude after 16 yrs. Adult height was reached at 16 years. Lowland girls were taller than highland ones at all ages (except at 9 yrs), differences obvious but not significant between 6 to 8 yrs and practically disappeared at age 15. Boys show an opposite pattern: highland boys are taller than lowland ones (*Fig. 1*).

In *weight* the same pattern was found as in height. Lowland boys were heavier until 13 year than highland ones. They finished their growth at near the 50 percentile of Merida's standards while girls does above it but differences were not statistical significant (*Fig. 1*).

Both sexes have larger *sitting height* (*Fig.* 2) between 5 to 11 yr than Merida schoolchildren, and highland boys had a larger values after the age 15 and finished above the 50th centile of Merida values and girls after the age 16. Variation was great in *subischial lenght* (*Fig.* 2) after 13 yrs in both sexes but always below the 50th centile of Merida values, except at 10 yrs of age. The mean of the relation height/sitting height *100 or *Cormic index* for both sexes was 52 in Merida, 53 in low-altitude and 55 in high-altitude. In general, girls had a bigger *biacromial diameter* (*Fig.* 3) than boys until 14 yrs; differences seemed greater between highland and lowland girls after 15 yrs and lowland girls had bigger values. Boys in both groups had approximately the same values at all ages, and under the 50th centile for Merida and reached approximately the same values at age 18. Lowland boys had a larger biiliac diameter (*Fig. 3*) than girls until 9 yrs. Adolescent girls presented greater values. After the age 15 highland girls were bigger, both groups were finishing up their growth at the 50th centile for Merida. Differences in all measurements were not statistical significant in both sexes.

The nutritional pattern was different in each community studied, the main *protein intake* of people living at high altitude came from milk, while that of people living at low altitude derived from the meat. In both cases the diet was qualitatively and quantitative bad, and fruits, vegetables were consumed less. *Haemoglobin* values were different in boys and girls living at high and low altitude, they were 14.94 ± 0.84, and 14.42 ± 1.03, and 13.68 ± 1.10, and 13.08 ± 1.41 g%, respectively Merida children (medium altitude) were 13.90 ± 1.01 and 13.20 ± 0.98 g%.

Discussion

Most researchers have concluded that the growth of highland children is delayed relative to that of lowland children, as a result of hypoxia, an interpretation supported by animal experimentation data (Hunter and Clegg 1973, Shaw and Basset 1976). This pattern of slow and prolonged growth resulting in smaller adult size, has been interpreted as an adaptative response to atmospheric hypoxia (Frisancho 1981). However, the magnitude of the effect of hypoxia in human linear growth vary considerably between studies and there are contradictions. Such findings are presumably due to confounding of comparisons by differences between altitude zones in enviromental agents other than the partial concentration of oxygen. Although physical enviromental agents, such as cold, may be involved (Rothammer and Spielman 1972), it is more likely, given the magnitude of the variability, that the primary cause of confounding is variation in general socioeconomic conditions (Frisancho 1981).

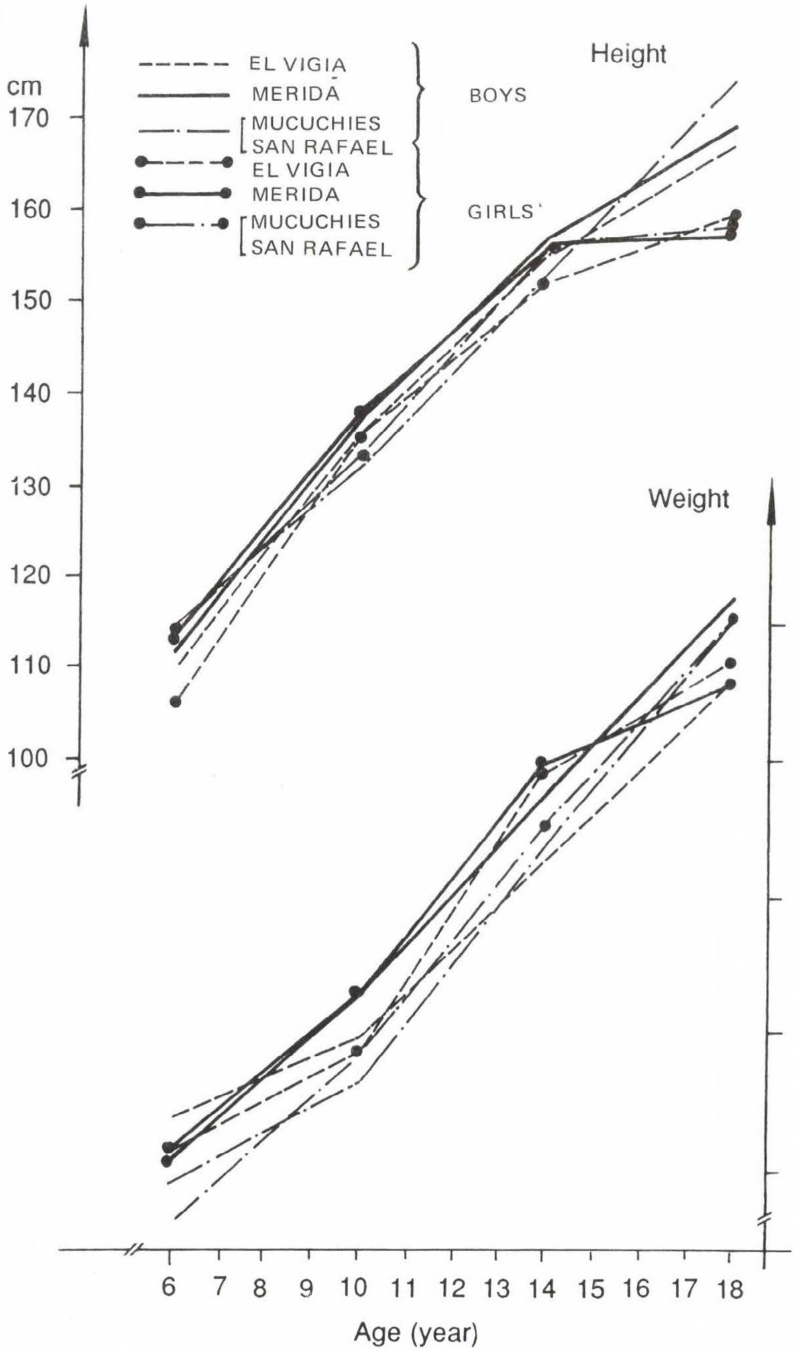

Fig. 1: Distance curves for height and weight: high altitude (San Rafael de Mucuchies) and low altitude (El Vigia) Venezuelan schoolchildren; males and females compared with the 50th centiles of Merida Reference

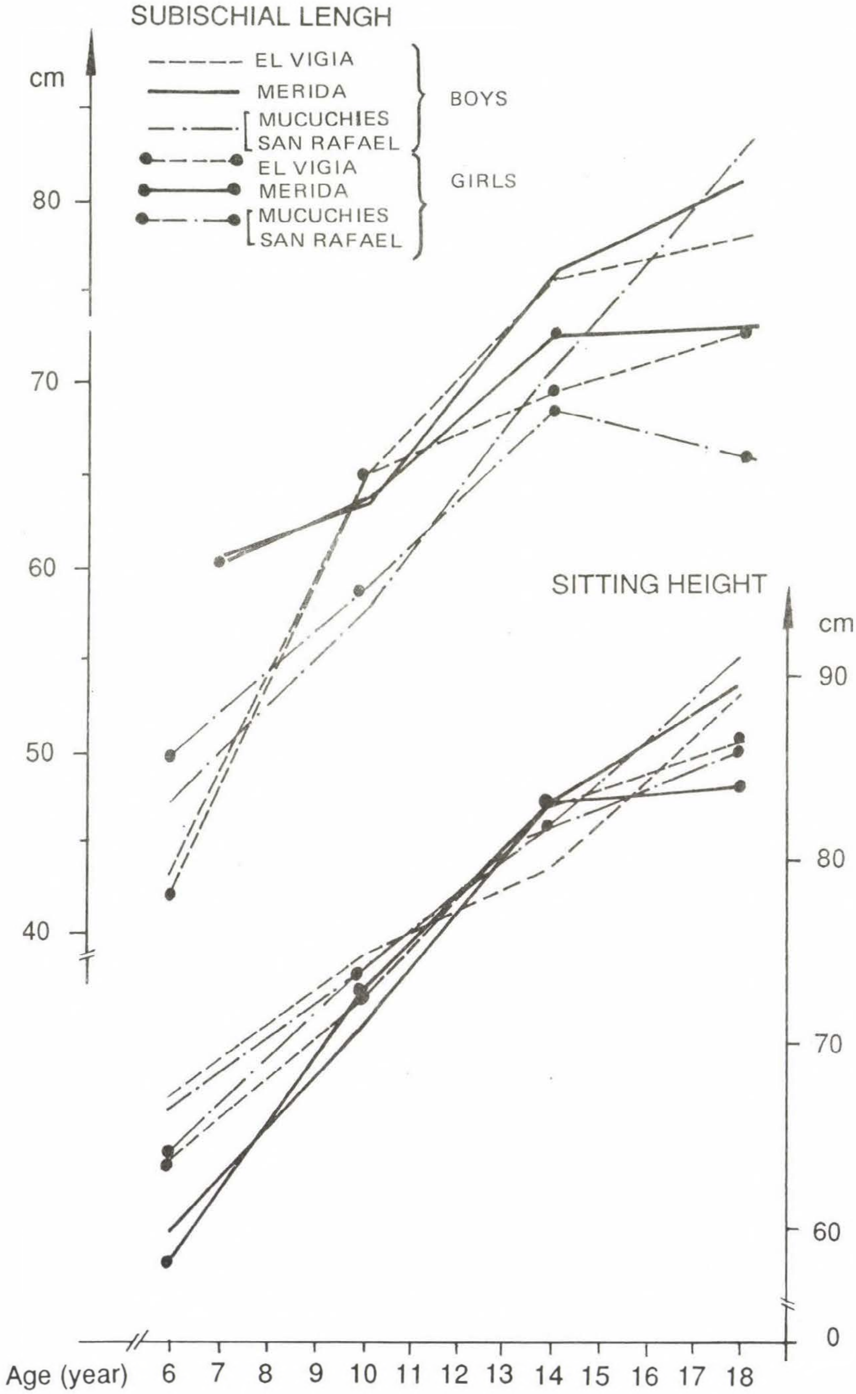

Fig. 2: Distance curves for subischial lengh and sitting height high altitude (San Rafael de Mucuchies) and low altitude (El Vigia) Venezuelan schoolchildren; males and females compared with the 50th centiles of Merida Reference

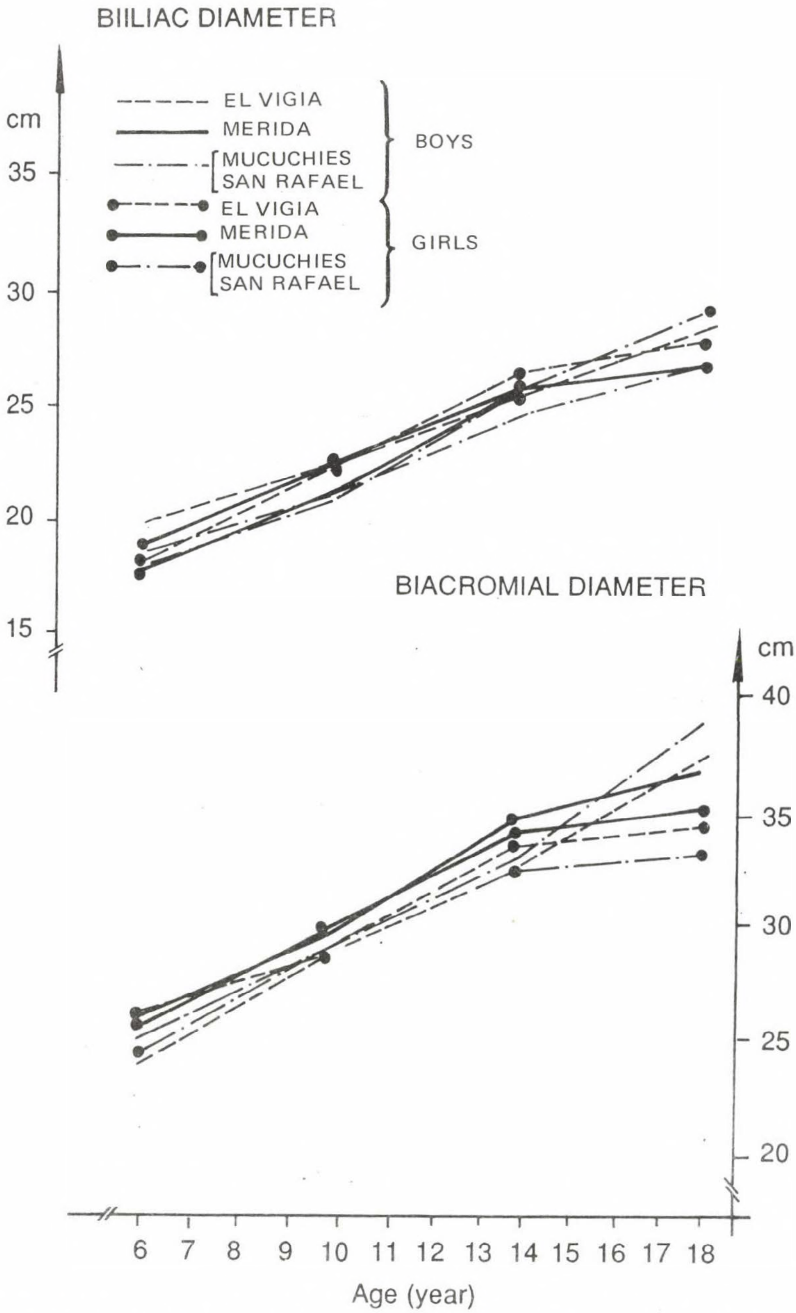

Fig. 3: Distance curves for biiliac and biacromial diameter: high altitude (San Rafael de Mucuchies) and low altitude(El Vigia) Venezuelan schoolchildren; males and females compared with the 50th centiles of Merida Reference

Our findings showed that height, weight, sitting height, subischial lenght and biiliac diameter values were higher in high altitude boys; however the biacromial diameter was lower.

Among girls the differences between those living at high altitude and those living at low altitude were less and only sitting height and biacromial diameter were higher in highland girls. It must be stated that the variation in all body dimensions were during the growth period, that is to say for boys under 16 yrs of age and for girls under age 15. Similar resuts have been reported in other regions of Venezuela (López et al. 1987). These differences tended to disappear when reaching adult values and it is different of that reported by other authors (Gupta 1981, Harrison 1969, Hoff 1974, Beall 1981, Frisancho 1981) for Sherpas and Peruvians and it is coincident with that reported by Pawson (1977) and Greksa (1984, 1990). The fact that differences tended to disappear in adults support the idea that it may be due to genetic factors more than the effect of altitude on growth, Cormic index usually ranges from 47–57, at least between 8 years to age 16 (Cruz-Coke 1977) and it also varies with ethnic group. Our children have a mean index of 53.8 at the mentioned ages, this figure is half way the index registered for European and African populations and suggest our hybrid extraction. On the other hand, enviromental factors seemed to play an important role in growth of children as has been stated recently. Leonard (1989, 1990) has demonstrated that health and nutritional status may have influenced Nuñoa growth patterns to a greater extent that was originally recognized. In our study both high and low altitude children had a deficient diet not only in quantity but quality, haemoglobin and haematocrit values showed that deficiency in food but not in a great extent as we could expected. Growth before 15 years in both sexes reflects the clear pattern of delay in growth and puberty that has been described previously for high altitude children. In a previous report the author (Pereira et al. 1987) showed that puberty was early in lowlanders and late in highlanders and differences seemed to reflect more the urban-rural characteristics than diet and socioeconomic conditions.

We can concluded that variations in growth of Venezuelan schoolchildren may be due to differences in the "tempo" of growth between populations and to genetic and enviromental conditions, specially nutrition than only an effect of hypoxia on growth.

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Paper sent to the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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Anthrop. Közl. *33*; 291–298. (1991)

REGIONAL DIFFERENCES IN GROWTH OF VENEZUELANS

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Abstract: *Patterns of growth were studied in 29283 subjects, aged 1 to 18 years, from the Caracas Metropolitan Area (CMA), Northeastem (NER), Midwestern (MWR) and Zulia (ZR) regions, who were measured as part of a cross-sectional survey (Project Venezuela) between 1981–1985. A one-way analysis of variance was used to contrast means and Preece-Baines Model I (PBI), to fit the height data and estimate the biological parameters. Significant differences between the (CMA) and the (MWR) and (ZR), from age 2 onwards and with the (NER) until puberty, were maximal during puberty and minimal in adult height (AH), with the exception of Zulianos, 3.3 cm shorter than (CMA) men. Variation in tempo was greater in girls, with Zulianas maturing earlier, so that they were large for their age independent of final size. Differences during growth reflect disadvantageous environmental conditions of the regions, while the similarity in (AH) is explained by the influence of genetic factors at the end of growth.*

Key words: *Growth; Height; Curve-fitting; "Tempo" of growth; Maximal annual increment.*

Introduction

Worldwide population differences in body size and rate of growth result from the interaction of genetic and environmental factors, so that the former may predispose towards a greater or lesser ecosensitivity (Eveleth 1986). Nutrition and hygiene, among other environmental factors, determine the "quality of life". Thus, physical growth is considered a good indicator of the latter and as such, has been used to assess and monitor the socioeconomic status of a community (Bielicki 1986). On the other hand, the height of individuals is expected to reflect the genetic potential for size in those environments that do not limit growth. Studies on the growth pattern of populations have indicated that genetic differences become more obvious as growth progresses and most evident at the end of growth (Martorell and Habicht 1986).

Venezuela is characterized by large geographical and demographic differences. The ethnic composition is mestizo: results of immunogenetic studies show an admixture of the whole population, with high frequencies of caucasoid-derive antigens, frequencies of Amerindian-derived antigens intermediate between the Amerindian communities and the Spanish population, and low frequencies of African-derived antigens. Caucasoid-derived antigens were significantly higher in the Caracas Metropolitan Area as compared to other regions (Fundacredesa 1985, Echerverría-Pérez 1988).

Growth studies conducted in Venezuela between 1936 and 1978, has shown similarities in size between upper strata children as compared to international standards and large differences between lower strata children and these last (Limongi et al. 1974, López-Contreras et al. 1981). In fact, upper strata children measured in 1976 in the Caracas Metroppolitan Area (Méndez-Castellano et al. 1986a), follow the British median for height throughout growth.

Project Venezuela, a National Human Growth, Nutrition and Family Survey, was designed to assess the health and nutritional status of the population, in order to establish policies and priorities and to serve as baseline for the evaluation of government programmes, as well as to collect data for the construction of national standards. Preliminary reports have been published in which differences between the social strata in size, maturation (age at menarche) and certain biological variables (body iron) are presented. These reports have shown Caracas children to be heavier, taller and to mature earlier than children from other parts of the country; the better living conditions, health and nutritional status have been suggested as explanations (López-Contreras et al. 1981, Farid-Coupal et al. 1981, López-Contreras et al. 1982, Taylor et al. 1988). However, regional differences as such have not been properly studied.

This report deals with the comparative growth of Venezuelan boys and girls from four regions; variations solely due to differences in maturation as opposed to those in final height have been considered. The Preece-Baines Model I (Preece-Baines 1978), designed for fitting longitudinal adata in individuals, was used for the comparison between populations. Tanner et al. (1982) showed that it can be used to fit cross-sectional data and produce efficient estimates of tempo of growth and adult final height and consider it most adequate for the comparison of growth between populations (Tanner 1986).

Materials and Methods

The study was conducted from 1981 to 1985 as part of Project Venezuela. Sample size was fixed using height at age seven for a precision of ± 0.3 cm at the 3rd and 97th centiles fora total of seven administrative regions, two localities (urban and rural) and five social strata, according to Graffar's method modified for Venezuela by H. Méndez-Castellano (1986b). Random sampling was taken from well-baby clinics, schools and household sampling. The age range of 1.0 to 18.0 years was chosen for this analysis: 8874 from the Caracas Metropolitan Area (CMA), 6647 from the Northeastern Region (NER), 8683 from the Midwestern Region (MWR) and 5179 from the Zulia Region (ZR). In the (NER) and (MWR), 14% belonged to the higher and middle strata (I + II + III), 31 to 40% to stratum IV and 45 to 54% to the lowest stratum V, whereas in the (ZR), 19% belonged to strata I + II + III, 55% to stratum IV and 34% to stratum V. The Caracas Metropolitan Area social structure was 28% in the (ZR) and 100% in the (CMA).

The Caracas Metropolitan Area (CMA) contains 20% of the population of Venezuela and is totally urbanized; 12% of its inhabitants are immigrants and 40% are migrants from other parts of the country. The Midwestern Region (MWR) contains 7.3% of the population, is 75% urban, with only 1.4% of immigrants. The Northeastern Region (NER) contains 12.8%of the population; it is 80% urban with 3.6% of immigrants. The Zulia Region (ZR) represents 12% of the population, is 84% urban with 8% of immigrants (OCEI 1987).

Data collection included nineteen anthropometric measurements; only height will be presented in this paper. All subjects were measured by three teams of trained anthropometrists, according to Tanner et al. (1969), using a Harpenden infantometer for supine length up to age 2 and a portable Harpenden stadiometer for stature afterwards. A 0.3 cm mean deviation between measurers was recorded.

A one-way analysis of variance (ANOVA) was conducted and significance measured with an F ratio for a confidence level of 5%. Subsequently, the Preece-Baines Model I (PBI) (1978) was fitted to the original means, using the Growth Package Programme (Brown 1983). The biological parameters derived from the function coefficients were: Age at take-off (ATO), age at maximal increment (AMI), maximal increment (MI), height at take-off (HTO), height at maximal increment (HMI), adult height (AH), gain in height from (ATO) to (AMI) Δ(HTO–HMI), gain in height from (AMI) to (AH) Δ(HMI–AH), and adolescent gain in height Δ(HTO–AH). The following formula was used for studying the components of the differences in adult height Δ(AH): Δ(AH) = Δ in height at take-off (HTO) corrected+ Δ in adolescent gain ± Δ due to the delay in spurt. The difference Δ in (HTO) was corrected for the corresponding height at the earliest age at take-off of the two populations. In the case of sex dimorphism in height, Δ(AH) = Δ in height at girl's take-off + Δ in adolescent gain + Δ due to the boys' delay in spurt (Hauspie et al. 1980b, Brown et al. 1982). The pooled residual variances obtained by fitting the curve were 0.518 for boys and 0.203 for girls asnd the Runs Test was non significant at a 5% level. Finally, the means and yearly increments derived from the PBI fit were compared to the British population values (Tanner et al. 1966, Tanner et al. 1982).

Results

Significant differences were found at most ages between the (CMA) and the (MWR) and (ZR), and also from 2 to 12 years in boys and 3 to 12 years in girls between the (CMA) and the (NER). Children from the (MWR) and (ZR) were similar in height throughout growth, yet statistically different with regard to the (NER). The fitted mean constant distance and increment curves for height in boys from the four regions are shown in *Figures 1* and *2*, where a gradient from highest to lowest: CMA > NER > YR > MWR, between ages 2 and 11 in girls and 2 to 14 in boys is observed with the change at age 12 in girls and 16 in boys, to CMA > NER > MWR > YR. The differences between the mean values obtained in the (CMA) and the other regions, were already present at age 3±, reaching a maximum of 2 cm with the (NER) boys and girls between ages 10 and 12 and 8 and 11, respectively, of 2.5 to 3 cm between 7 and 13 years of age in boys and between ages 5 to 14 and 6 to 11 in the Zulia and Midwestern girls, respectively, while after puberty, differences between the (CMA) and the other regions diminished, although with Zulia differences of 3 cm in men and 1.8 cm in women were still evident at age 18.

Boys were approximately 1 cm taller than girls until 8 years of age; between 9 and 13 years of age, girls were taller than boys, from 14 years onwards, boys became progressively taller. Sex dimorphism in adult height was 13.8 cm in the (CMA) and (NWR), 12.9 cm in the (NER) and 12.2 cm in the (ZR) (*Table 1*).

The biological parameters derived from the PBI are summarized in *Table 1*. The pattern of tempo in boys is characterized by an earlier maturation in Zulia, specially at

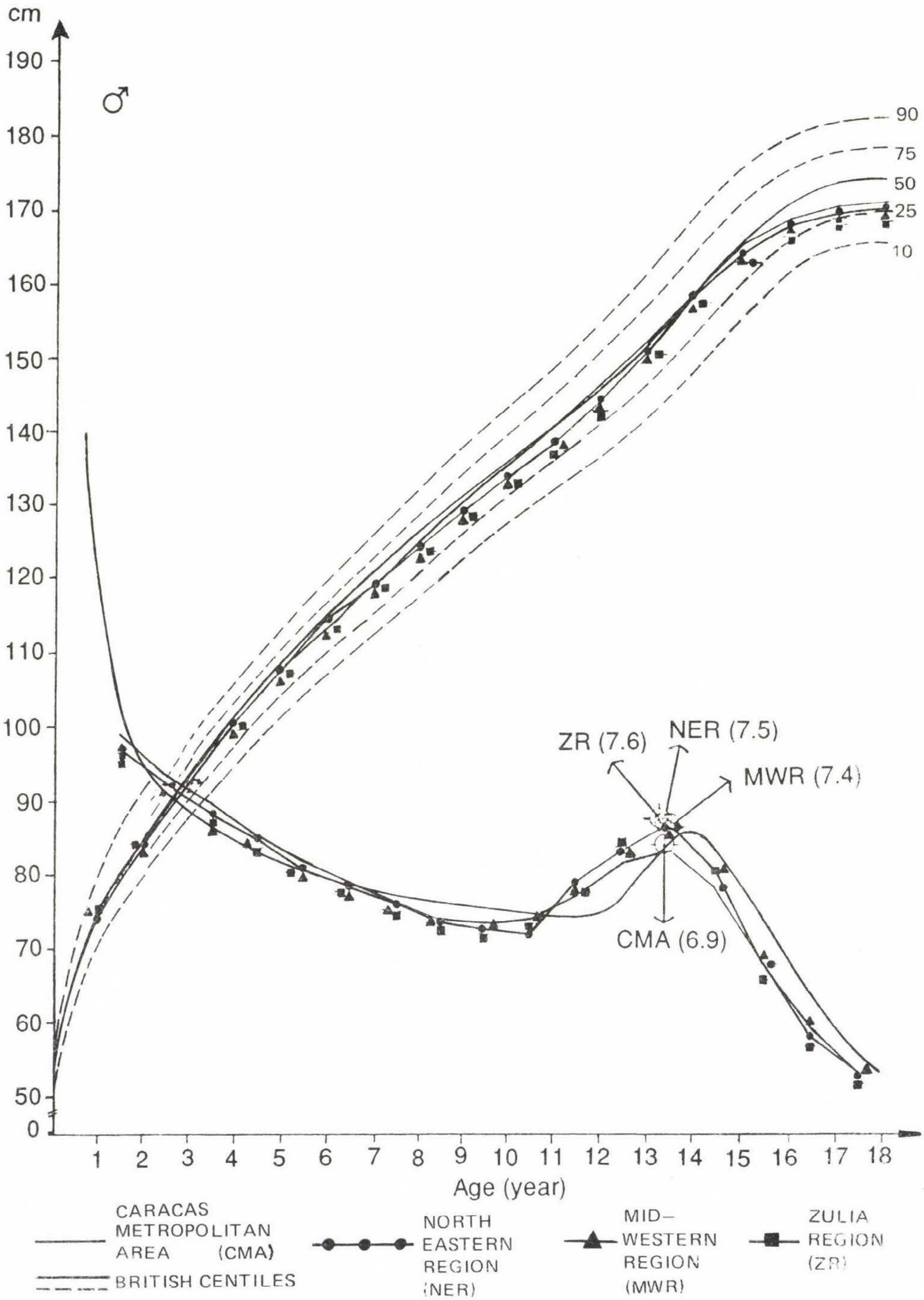

Fig. 1: Mean constant curves obtained by fitting the (PBI) Model to cross-sectional height data of Venezuelan boys from CMA (n: 4465), NER (n: 3128), MWR (n: 4251) and ZR (n: 2549), plotted on British Population Centiles

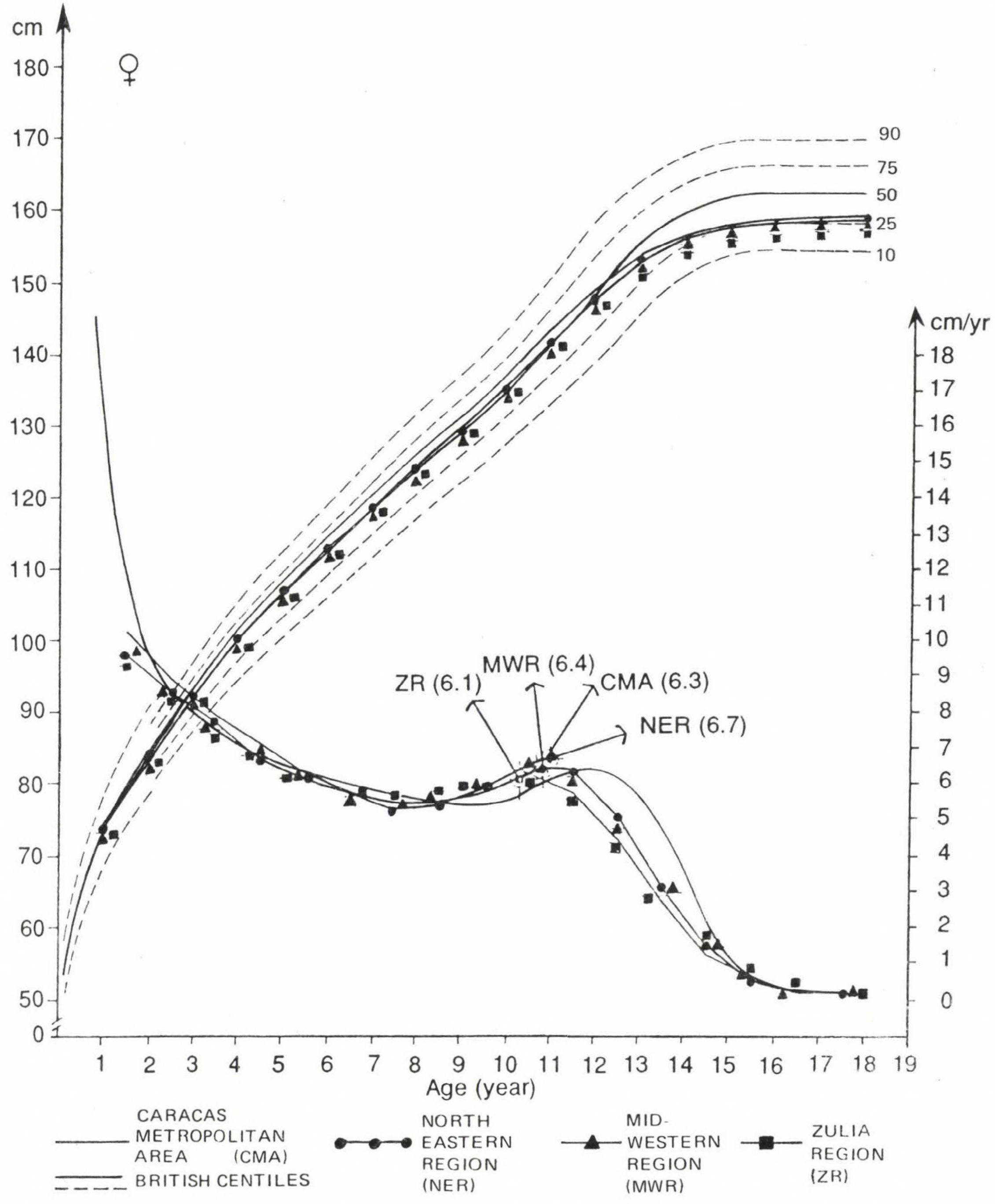

Fig. 2: Mean constant curves obtained by fitting the (PBI) Model to cross-sectional height data of Venezuelan girls from CMA (n: 4409), NER (n: 3519), MWR (n: 4432) and ZR (n: 2630), plotted on British Population Centiles

Table 1. **Derived biological parameters in four regions of Venezuela (PBI)**

Characteristics	Caracas Metropolitan Boys	Caracas Metropolitan Girls	Northeastern Region Boys	Northeastern Region Girls	Midwestern Region Boys	Midwestern Region Girls	Zulia Region Boys	Zulia Region Girls
ATO (yrs)	9.6	7.9	9.6	7.8	9.6	7.8	9.3	7.7
AMI (yrs)	13.4	10.7	13.4	11.0	13.5	10.9	13.3	10.3
MI/cm (yr)	6.9	6.2	7.5	6.7	7.4	6.4	7.6	6.1
HTO (cm)	134.4	125.3	132.2	122.5	131.3	121.5	131.1	121.1
HMI (cm)	155.6	141.4	154.5	141.3	153.9	139.5	152.9	136.9
AH (cm)	172.5	158.7	171.3	158.4	170.9	157.2	169.2	157.0
ΔHTO–HMI (cm)	21.2	16.1	22.3	18.8	22.6	18.0	21.8	15.7
ΔHMI–AH (cm)	16.9	17.4	16.8	17.2	17.1	17.6	16.3	20.2
ΔHTO–AH (cm)	38.1	33.5	39.1	36.0	39.7	35.6	38.1	35.9

take-off. Maximal increment was lower in the Metropolitan Area than in the other regions and the adolescent gain in height less than in the Northeastern and Midwestern regions. (HTO), (HMI) and (AH) followed a similar gradient to that described before: CMA > NER > MWR > ZR. At age 18, Metropolitan Area men were 3.3 cm taller than the Zulianos: 1.8 cm attributable to differences at take-off and 1.5 cm due to the delay in the spurt of the former.

The pattern in girls was also characterized by the earlier maturation in Zulia, specially at the moment of maximal increment (AMI), at 10.3 years, much earlier than in the other regions. Maximal increment in the (NER) was higher than in the other regions, and the adolescent gain was the greatest, in fact, 2.5 cm superior to that of the (CMA). (HTO), (HMI) and (AH) followed a similar gradient to that of boys. With regard to adult height, (CMA) women were 1.7 and 1.5 cm taller than the Zulia and (MWR) women: 1.0 cm because of the delay in the spurt of the former and the rest due to differences at take-off, modified by the adolescent gain, while the (AH) of the (CMA) and (NER) women was similar (*Table 1*).

Differences in tempo between boys and girls were most evident at the maximal increment (2.4 to 3 years earlier in girls), while the magnitude of the spurt was greater in boys, as was their adolescent gain. Adult sex dimorphism was 12.2 to 13.8 cm; this cannot be explained solely by the boys' greater adolescent gain: 4.6 cm in the (CMA), 3 to 4 cm in the (NER) and (MWR) and 2.2 cm in Zulia, nor by the differences in the girls'take-off: 0.7 to 0.9 cm, so that 8.5 to 9.1 cm of the dimorphism in adult height was due to the boy's delay in the pubertal spurt (*Table 1*).

Figures 1 and 2 show the similarity of the Metropolitan Area boys' mean heights with the British median until age 14, and the similarity to the 25th centile at the end of growth as well as the position of the means of the other regions around the 25th centile throughout growth. Metropolitan Area girls' mean heights were also similar to the British median until age 12, while those of the other regions followed a channel between the 25th and 50th centiles; at the end of growth, means corresponded to the 25th and 10th centiles. With regard to tempo, (ATO) in Venezuelan boys occurred 1 to 1.4 years earlier and (AMI) 0.5 to 0.7 years earlier; in Venezuelan girls, both of these parameters occurred 1 to 1.7 years earlier. Maximal increment in boys was, in general, above the British population value, whereas in girls it was lower, with the exception of the (NER).

Discussion

The PBI Model used for fitting the cross-sectional values of the four regions proved to be adequate; pooled residual mean squares compared favourably with other authors (Hauspie et al. 1980a, 1980b, Brown and Townsend 1982, Billewicz 1982). The raw differences were systematized and gradients were not altered; also, estimates of tempo of growth and adult height were provided, so that variations due to a dissimilar tempo were separated from adult size.

Metropolitan Area children were significantly taller than children from the Northeastern Region until puberty and significantly taller than children from the other regions throughout growth. This may reflect the social structure and the overall better living conditions of the capital and also to the fact that Caracas is a "melting pot" of migrants from the other regions (López Contreras-Blanco et al. 1987). The interregional differences observed were smaller than those between the upper and lower strata of Venezuela (López Centreras-Blanco et al. 1987), and similar to the values reported by Rona and Altman (1977). The changes in the height gradient with the adults from Zulia ending up the shortest, are the result of changes in tempo of the latter, especially of girls who mature faster, so that they were large for their age independent of their final size. Differences in adult height between the Metropolitan Area and Zulia were due, in a high proportion, to the delay in the spurt of the former. On the other hand, the similarities in height between the Metropolitan Area and the Northeastern Region adults, particularly women, can be explained by the fact that these exhibit a partial "catch-up". Sex differences in height during growth were as expected, but the period of the girl's prevalence occurred earlier, due to the faster maturation of Venezuelan females. Sex dimorphism of adults fell within the expected variability and was due primarily to the delay in the boy's adolescent spurt; other authors have found similar results (Hauspie et al. 1980a, Brown and Townsend 1982).

Finally, with regard to the British, Venezuelans, specially girls, behaved like early maturers; these differences in tempo are in accord with the larger differences in height observed after puberty in contrast to the smaller differences observed during growth. Similar results have been reported by others, sustaining the statement that genetic differences between populations are most evident after puberly (Martorell and Habicht 1986). The earlier maturation of Venezuelans has been reported before with regard to onset of puberty, age at menarche and skeletal maturity (Farid-Coupal et al. 1981, López Contreras et al. 1986a, 1986b, and 1987). This supports the need for recommending national norms.

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Paper sent to the Fifth International Symposium of Human Biology, Keszthely, Hungary, June 1991; Received 5 June, 1991.

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THE SUM OF SKINFOLDS AND THE O-SCALE SYSTEM FOR PHYSIQUE ASSESSMENT RATING OF ADIPOSITY

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Abstract: *The use of a sum of skinfolds to represent adiposity in the O-Scale physique assessment systems (Ross and Ward 1984, Ward et al. 1989) is based on the rationale that the thicker folds are accorded proportionally greater weighting than the smaller folds. This is why the sum of six skinfolds from different regions of the body is preferred to one or two measures or upper body sites only. Another advantage in using the sum of six sites is that the technical error of measurement is markedly reduced and as we demonstrate, the sum approximates theoretical expectancy in combining errors where the error at each site is assumed or known to be uncorrelated with that of other sites.*

Key words: *Adiposity; Error; Skinfolds; O-Scale System.*

Garn et al. (1987) recognizes that the sum of skinfolds provides an expression of relative adiposity and that the thicker folds are accorded disproportional weighting compared to smaller sites. This is precisely why the sum of six skinfolds was used in the *O-Scale System* (Ross and Ward 1985, Ward et al.1988) which provides adiposity ratings of males and females age 6 to 70 years old. In the design of the system, it was accepted that the adiposity rating should reflect upper limbs, torso and lower limbs. This is in marked contrast to methods which used only upper body sites. In 6 male and 7 female unembalmed cadaver dissections, the front thigh was the best predictor of dissectible adipose tissue mass in the males and the second best in females and best single site over all, and the medial calf the best discriminator in the females (Martin 1984).

The main advantage of the sum of six skinfolds is that is represents a regional sampling of the body and it is highly precise compared to measurement at any single site as illustrated in *Table 1* using the following formulae:

$$TEM = [(\text{sum } X_1 - X_2)^2 / 2n)]^{0.5}$$

$$\%TEM = 100\,(TEM / M_1)$$

where: TEM = the technical error of measurement
X_1 and X_2 = replicated scores in separate series
M_1 = mean of the first scores

This was illustrated using replicated measures on 50 adult males and females using Slim Guide calipers and the techniques specified by Ross and Marfell Jones (1990). In terms of the technical error of measurement, the sum of the six values used in the O-Scale System appeared to approximate the general formula (Beers 1957) when one assumes the error in each set is independent, rewitten as follows:

$$E = (e^2{}_1 + e^2{}_2 + \ldots + e^2{}_n)^{0.5}$$

As shown in *Table 1*, the obtained TEM and %TEM for the sum of six skinfolds was more stable than any of the single items. While we can rationalize values of the TEM for the sum higher in the females than theoretically projected (1.52 compared to 1.35 mm) by assuming some small covariance factor, we have no explanation for the lower values for the males (0.93 compared to 1.01 mm). Because individual profiles are sensitive to error as well as change, it is our practice to use the median of three measures from an initial and twice replicated series. This further enhances precision of measurement.

Table 1. **Technical error measurement for eight skinfold sites, the sum of six sites, and theoretical expectancy**

Skinfold Site	Men (n = 50)		Women (n = 50)	
	TEM mm	%TEM	TEM mm	%TEM
Triceps	0.30	3.23	0.40	2.65
Subscapular	0.36	3.27	0.36	3.24
Biceps*	0.23	5.11	0.29	4.46
Iliac Crest*	0.62	3.88	0.83	7.35
Supraspinale	0.34	4.86	0.40	4.08
Abdominal	0.62	3.90	0.87	5.76
Front Thigh	0.47	4.12	0.64	2.79
Medial Calf	0.28	3.68	0.45	3.31
Sum of 6 (–*)	0.93	1.49	1.52	1.73
Theoretical	1.01	1.62	1.35	1.55

In the O-Scale System,the sum of skinfolds at triceps, subscapular, supraspinale, abdominal, front thigh, and medial calf sites scaled to a common stature is expressed as a stanine rating for separate norms for males and females yearly age 6 to 18, 19 and 20, and in five year increments thereafter until age 70. The rating is only an indicator of relative adiposity. This is interpreted by comparison with a proportional body weight stanine rating, i.e. the subject's obtained body weight (w) scaled to a standard stature (170.18 cm) raised to the third power, $w\ (170.18/h)^3$.

As shown in a client print out shown in *Fig. 1* to *4* the O-Scale System provides for three tired comparisons. The first provides for comparison of adiposity and proportional weight in reference to norms for the subject's age and sex. The second provides a raw score summary of eight skinfolds, ten girths, two bone breadths and four skinfold corrected girths relative to the 4th, 50th and 96th percentiles which provides a window on the norms. The third tier provides a proportionality profile of individual items scaled to the subect's stature-adjusted age and sex norm. When the A rating exceeds the W rating, one looks to the individual proportionality profile and expects some dominance of the individual and regional skinfolds. If, on the other hand, the proportional weight rating is dominant, one expects, in the most recent version, the pattern of ten girths, two bone breadths and four skinfold corrected girths will show the individual structures contributing to the dominance. A fourth page provides an explanation of the system for the client.

O-Scale assessment : spski page 1 of 4

ROSSCRAFT
14732 16-A Avenue, Surrey, BC, Canada V4A 5M7
(or) PO Box 2043, Blaine, WA, USA 98230
Tel (area code 604): 292 3319, 538 3362, FAX 604 538 3362
Kinanthropometric products and services

O-Scale Rating For : spski
Date : 23/10/74

Age (decimal years)	: 17.2
Height (centimeters)	: 173.1
Weight (kilograms)	: 68.2
Sum of 6 Skinfolds (millimeters)	: 48.9
Proportional Sum of 6 Skinfolds (mm)	: 48.1
Proportional Weight (kilograms)	: 64.8

```
  |..1..|..2..|..3..|..4..|..5..|..6..|..7..|..8..|..9..|
A |     |     |     |     |  *  |     |     |     |     |
  |.....|.....|.....|.....|.....|.....|.....|.....|.....|
W |     |     |     |     |     |     |  *  |     |     |
  |.....4%...11%...23%...40%...60%...77%...89%...96%....|
```

A-Rating : This is your Adiposity rating based on the proportional sum of six skinfolds compared to your age and sex norm. It is your 'fatness' rating.
W-Rating : This is your Proportional Weight rating. This is compared to your age and sex norm. It is a rating of Weight for Height, NOT of 'fatness'.
The A and W ratings give a general description of physique. A difference between the A and W ratings is an indication of your musculo-skeletal development. A more detailed description of physique is provided by the size listings and proportionality profile which follow.

KINEMETRIX (Serial # 52100)

Fig. 1

O-Scale assessment : spski page 2 of 4

SIZE PROFILE

Male age 17.2	Present	Norm Percentiles 4%	50%	96%
Weight	68.2	51.9	67.3	82.0
Height	173.1	167.1	176.3	189.8
Skinfolds				
Triceps	8.4	4.9	8.0	20.5
Subscapular	8.8	5.5	8.1	19.2
Supraspinale	5.2	3.5	6.0	20.2
Abdominal	7.7	4.9	9.1	34.0
Front Thigh	10.8	6.9	10.8	25.7
Medial Calf	8.0	4.4	8.0	17.1
Girths				
Arm (relaxed)	28.8	24.2	28.7	33.2
Arm (flexed)	31.4	27.1	31.2	35.0
Forearm (maximum)	26.8	24.7	27.0	29.7
Wrist	17.0	15.6	17.1	18.6
Chest	93.5	80.9	91.5	101.0
Thigh	54.4	47.7	54.2	63.2
Calf (maximum)	36.1	32.4	36.4	41.0
Ankle	22.2	20.2	22.7	25.2
Widths				
Humerus	7.4	6.4	7.0	7.8
Femur	9.7	8.8	9.8	10.6
Corrected Girths				
Arm	26.2	22.2	25.6	29.7
Chest	90.7	78.5	88.3	97.9
Thigh	51.0	44.4	50.2	58.5
Calf	33.6	29.7	33.2	37.5

KINEMETRIX (Serial # 52100)

Fig. 2

O-Scale assessment : spski page 3 of 4

PROPORTIONALITY PROFILE

Your measurements are scaled to a common stature and then plotted relative to your age and sex norms.

```
                             4%        50%       96%
Weight               .......|.........|.....*...|................

  Skinfolds
Triceps              .......|.........|*........|................
Subscapular          .......|.........|*........|................
Supraspinale         .......|...*.....|.........|................
Abdominal            .......|....*....|.........|................
Front Thigh          .......|......*..|.........|................
Medial Calf          .......|.........*.........|................

  Girths
Arm (relaxed)        .......|.........|.*.......|................
Arm (flexed)         .......|.........|.*.......|................
Forearm (maximum).......|.........|.*.......|................
Wrist                .......|.........|.*.......|................
Chest                .......|.........|....*....|................
Thigh                .......|.........|.*.......|................
Calf (maximum)       .......|.........|.*.......|................
Ankle                .......|.........*.........|................

  Widths
Humerus              .......|.........|......*..|................
Femur                .......|.........|.*.......|................

  Corrected Girths
Arm                  .......|.........|..*......|................
Chest                .......|.........|....*....|................
Thigh                .......|.........|..*......|................
Calf                 .......|.........|..*......|................
```

KINEMETRIX (Serial # 52100)

Fig. 3

O-Scale assessment : spski page 4 of 4

THE O-SCALE PHYSIQUE ASSESSMENT SYSTEM

More information on your O-SCALE SYSTEM physique assessment is presented below. Please ask your health, diet or fitness professional if you do not understand any part of the print-out. Page 1 displays and explains your ratings of Adiposity (A) and Proportional Weight (W). Both A and W ratings are scaled from 1 to 9. A rating of 1 indicates that you are in the bottom 4% of the norm, while a 9 indicates that you are in the top 4%. A rating of 5 would rank you in the middle 20%. The percentiles associated with each rating are on the graphic display.
The A and W ratings are not necessarily the same. If they are, it means the individual has an average amount of adiposity ('fatness') for someone of that weight. In more active people, the proportional weight rating is usually higher than the adiposity rating. In this situation, the higher weight rating is not a result of the individual's 'fatness' and must therefore be due to greater development of some other body component(s). Greater activity level would cause an increase in muscularity, and possibly bone mass. An A-rating higher than the W-rating would indicate low musculo-skeletal development for someone of that body weight.

The Size Profile lists your measurements along with selected values for your age and sex norm. The Proportionality Profile conveys different information about your physique. Everyone is scaled to the same height, the scaled values allow comparisons between individuals to be made. This is important, as it is possible to be small in size, yet large in body proportions. Short people tend to be proportionally heavier and more squat than tall people. The proportionality profile is particularly useful in repeated assessments when a change in your physique has occurred. The profile reveals the pattern of change, which may not be uniform throughout your entire body.

One commonly asked question is 'What is ideal?'. There are no A and W ratings ideal for all individuals. The O-SCALE SYSTEM explains your physique status at the time of measurement. Your health and fitness professional will use his or her experience to guide your future training or dietary regime. If a change in your physique is expected, then re-measurement at a future date will give a precise, unbiased view of these changes. Use the O-SCALE SYSTEM to monitor these changes in your body due to dietary and/or exercise program modification.

KINEMETRIX (Serial # 52100)

Fig. 4

While we recognize the sum of six skinfolds sampling upper and lower limbs and torso is a stable and useful measure of relative adiposity, we do not advocate its use as a single indicator. The sum does not obviate the need to look at the individual proportionality pattern. The proposition that an arbitrary weighting of four upper body skinfolds be used to indicate adiposity assumes (1) the sites selected are representative of over all adiposity in all subjects and (2) there is an optimal weighting for each contributing site and some biologically appropriate criterion to make this decision. There is no evidence to support this proposition and what limited direct anatomical evidence there is suggests there must be a regional sampling to account for individual differences in subcutaneous adipose tissue deposition.

Acknowledgement: 100-SSHRC: Social Sciences and Humanities Research Council of Canada.

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Received 28 January, 1992.

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Anthrop. Közl. *33*; 305–312. (1991)

ETHNIC DIMORPHISM IN PREPUBESCENT BOYS

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Abstract: *Striking proportional differences between black and white athletes measured at the Olympic Games in Mexico City in 1968 raises questions about similar ethnic dimorphism in children. Proportionality profiles constructed from mean values taken from cross-sectional data base of white boys from Coquitlam, British Columbia and black boys from Ibadan, Nigeria (ages, from 5 to 11 years) demonstrate clearly that the ethnic-specific traits observed in adults also exist in children. Previous reports that black males have proportionally longer limbs, narrower hips and shorter sitting heights compared to white males are confirmed.*

Key words: Proportionality; Anthropometry; Black and white children; Phantom stratagem.

Introduction

Consistent proportional morphological differences between white and black Olympic athletes measured in Mexico City in 1968 across a range of track and field specialties were demonstrated by Ross (1978) using the Phantom stratagem (*Figure 1*). Phantom z-values simply represent departures, in standard deviation units, from a reference physique after a correction has been made for body size (see Ross and Marfell-Jones 1991). The finding that black athletes had narrower hips and longer limbs than white athletes is clearly identifiable on the proportionality profile in *Figure 1*; non-overlapping of standard error (SE) bars being the criterion for significance. Since the bars in *Figure 1* represent 2 SE, it is not clear on the diagram that proportional trunk length was also found to be significantly smaller in the black athletes compared to the white athletes in that study (Ross 1978). Differences larger than the 2 SE overlapping range, however, were not observed for weight and biacromial (shoulder) breadth.

Differences among children have been reported (Evelith and Tanner 1976, Krogman 1970, Malina, Brown and Zavaleta 1987, Martorell et al. 1988, Meredith 1968), although not always in terms of proportional size. Whenever proportionality assessments have been attempted, however, ratios and indices have been used. Problems with the interpretation of ratios stemming from allometric differences in the variables of the numerator and the denominator (and, hence, the confusion of mixed variances) have been identified by Packard and Boardman (1987) and emphasize the need for alternative approaches to the study of human proportionality.

We have found that the study of human proportionality is greatly simplified by the use of the Phantom stratagem (see Ross and Marfell-Jones 1991). In the present study, proportional morphological characteristics of black and white children are re-examined using this method. How proportional differences between the two age-matched, cross-sectional samples of prepubescent black and white boys compare with the differences observed among adult black and white male Olympians relative to the same standard reference human can then be determined.

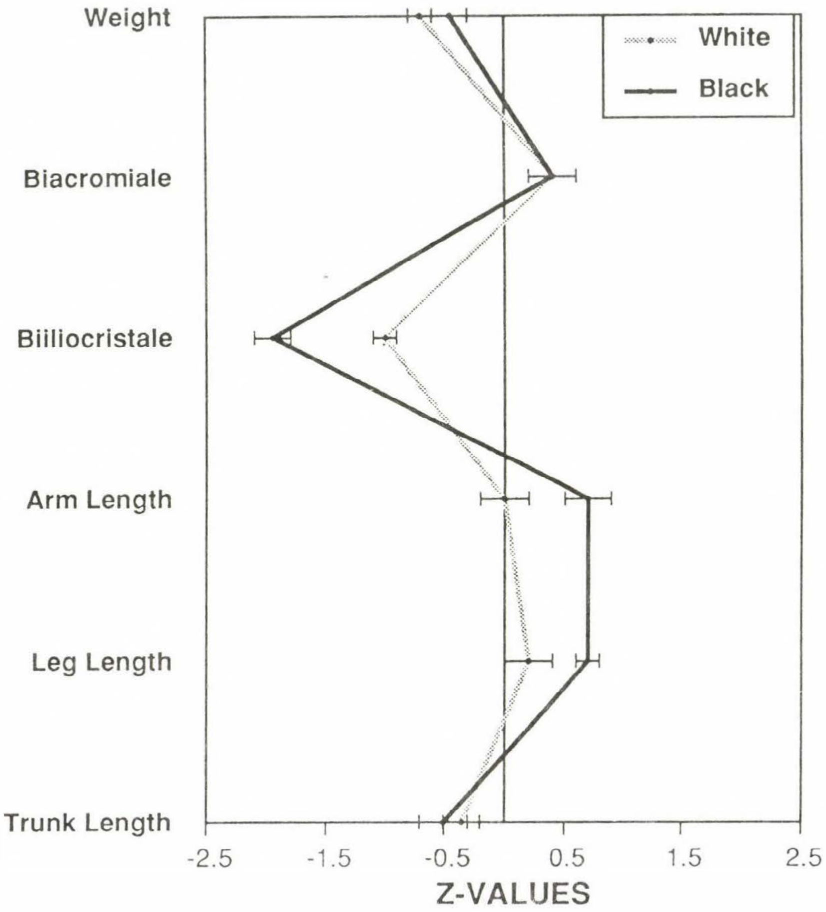

Fig. 1: Proportionality profiles showing mean phantom z-values (± 2 SE) for black (N = 107) and white (N = 88) male runners and jumpers. From Ross, 1978

Subjects and Methods

A cross-sectional sample of boys from Coquitlam, British Columbia served as the representative white sample, while Nigerian boys from fee-paying schools in Ibadan, Nigeria served as the black sample. Subject numbers and descriptive statistics of the variables used in this study are provided in *Table 1.* Age categories are standardized such that a 5 year old is any boy between 5.000 and 5.999 in decimal years (see Tanner 1978).

The N of 9 for each age group in the Nigerian sample results from a research design consisting of two phases:

Phase 1. Measurement of weight and height of a stratified, random sample (N = 522) selected from the fee-paying school system in Ibadan.

Table 1. **Anthropometric means and standard deviations of variables used in the comparison of proportional morphological differences between black and white boys**

Age	Group (yrs)	N	Height (cm)	SD	Weight (kg)	SD	Biacromial Breadth (cm)	SD	Biiliocristal Breadth (cm)	SD	Arm Length (cm)	SD	Leg Length (cm)	SD	Sitting Height (cm)	SD
5	Black	9	112.1	4.75	17.7	2.73	23.9	1.36	16.8	1.66	49.7	2.98	52.5	2.88	59.6	2.19
	White	14	115.9	6.58	21.0	2.34	25.1	1.22	18.4	0.69	50.0	3.83	52.3	4.19	64.0	3.18
6	Black	9	120.4	4.01	21.1	2.79	25.7	0.97	18.0	0.86	55.0	2.17	58.9	3.72	61.5	3.52
	White	18	121.8	3.54	23.9	3.04	26.4	1.11	19.3	0.99	52.9	1.81	54.7	2.43	67.1	1.97
7	Black	9	123.7	4.62	21.4	3.37	26.2	1.29	18.2	1.07	55.9	1.94	59.5	2.52	64.2	2.88
	White	19	125.7	6.31	25.4	4.19	27.4	1.42	19.5	1.02	54.7	3.69	57.1	3.81	68.6	2.96
8	Black	9	126.3	3.94	22.8	3.00	27.1	1.63	18.7	0.99	57.5	2.04	60.4	2.31	65.9	2.31
	White	30	132.3	7.39	28.6	5.27	28.5	1.62	20.6	1.44	56.6	3.33	61.2	4.67	71.2	3.20
9	Black	9	135.5	4.11	26.6	3.18	28.0	1.66	19.2	1.58	61.4	2.93	66.3	3.01	69.2	1.98
	White	21	136.3	6.47	30.5	4.08	29.6	1.73	21.1	1.28	59.1	3.19	64.1	3.73	72.2	3.50
10	Black	9	137.8	8.66	28.8	6.19	29.3	2.68	19.9	0.96	62.8	3.78	67.2	5.15	70.5	4.44
	White	21	142.8	7.13	35.9	7.60	30.9	1.90	22.3	1.61	62.2	3.74	68.0	5.04	74.8	2.69
11	Black	9	141.1	8.85	29.8	4.39	29.2	2.30	20.3	0.91	64.1	3.97	70.6	5.25	70.5	4.50
	White	21	147.3	7.04	39.9	8.6	31.5	1.88	22.7	1.77	64.5	3.35	70.3	4.62	76.9	3.36

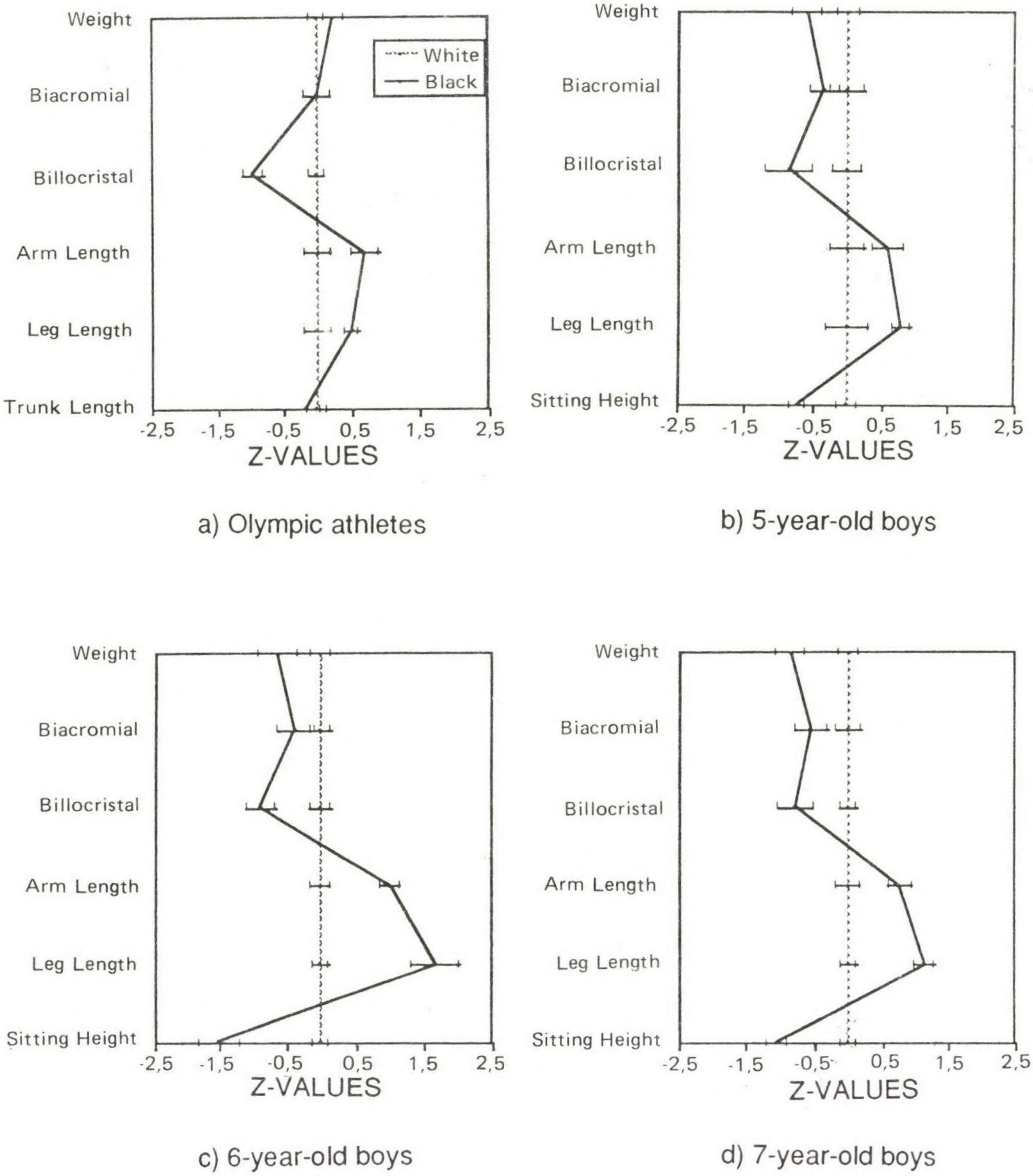

Fig. 2: Proportionality profiles showing phantom z-values for black and white males

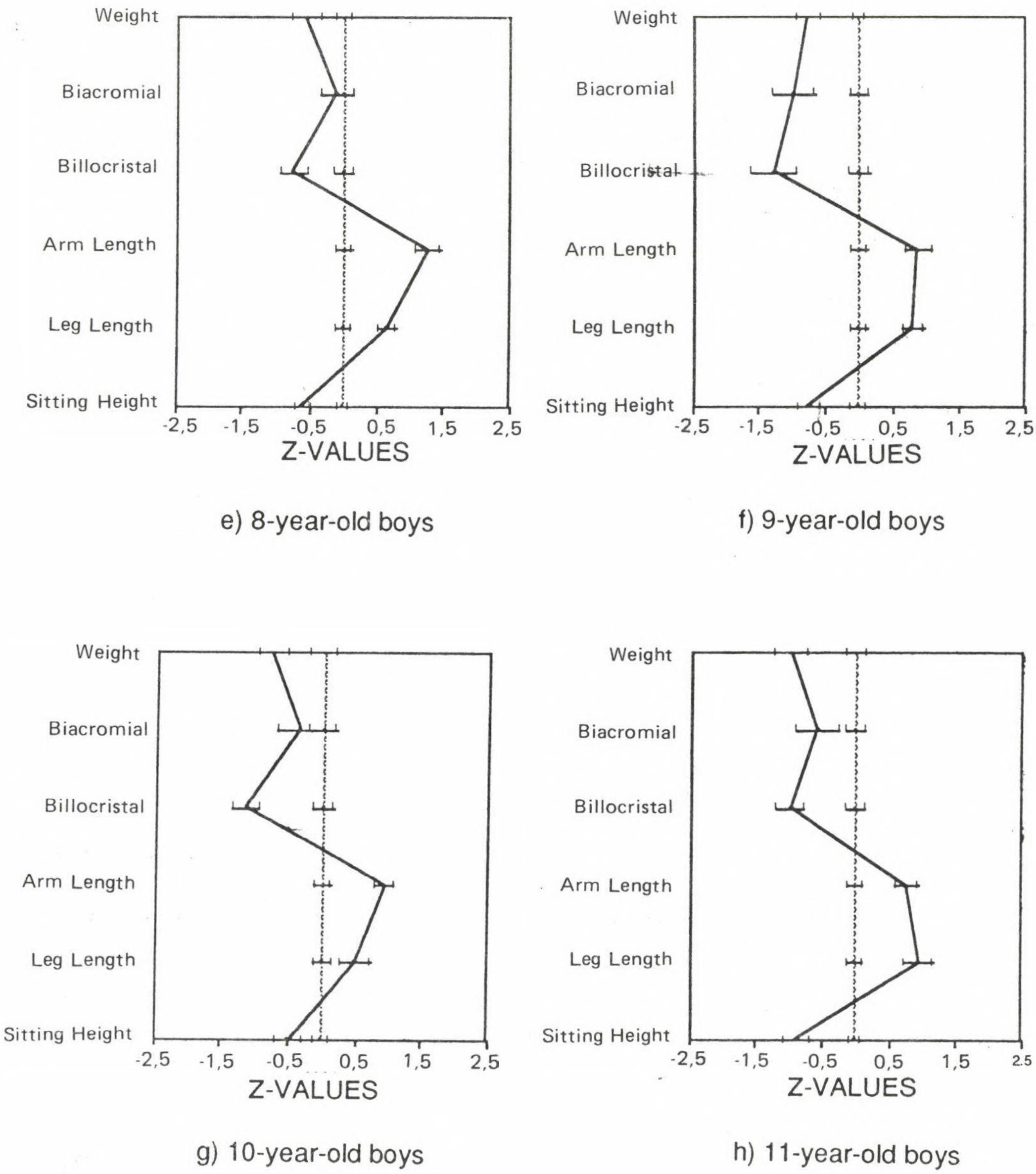

Fig. 2 continued

Phase 2. Selection of highest, lowest and median poderosity boy from each age category at each of three schools to ensure the widest range of body types for complete anthropometric assessment. The Benn Index (Benn 1971) was used in the calculation of ponderosity. Thus, the black means in *Table 1* represent a pooling of anthropometric data from three highly ponderous boys, three minimally ponderous boys and three boys each of whom had a ponderosity which represented the median value for the given age group at a given school (N = 9).

All of the measurements except for arm length were measured in the same manner for both black and white samples following guidelines identical to those described in Ross and Marfell-Jones (1991). In the white sample, arm length was determined by subtracting dactylion height from acromiale height using a Harpenden anthropometer. Alternatively, a segmometer constructed from cotter pins and a steel construction tape was used to measure direct segmental lengths in the black sample. Thus, for the black children total arm length is the sum of arm length, forearm length and hand length.

Phantom z-values of the variables of each subject were calculated and group means and standard errors of the means were then computed to construct the proportionality profiles shown in *Figure 2b–2h*. For ease in the comparison of black and white differences across age categories, the profiles were adjusted with white values at the center line. Proportional differences are considered to be significant when the standard error bars do not overlap.

Results

To facilitate comparisons between the children and the adult Olympians, the proportionality profile of the athletes is provided in standard format in *Figure 2a* with the white value set the center line as described above. Clearly, there is consistency in the overall proportionality pattern at every age (*Figure 2b–2h*), with the black boys having narrower biiliocristal breadth, longer limb lengths and smaller sitting height than their white counterparts. Whenever there was a significant difference in proportional biacromial breadth (i.e. at ages 7, 9 and 11) it was in the direction of blacks being smaller than whites, although there was not a persistent difference with respect to this variable across all age groups. Also, the Nigerian boys were consistently smaller in proportional weight than the Coquitlam boys.

Discussion

Ethnic dimorphism in prepubescent children has been reported previously (Evelith and Tanner 1976, Krogman 1970, Malina, Brown and Zavaleta 1987, Martorell et al. 1988, Meredith 1969). While ethnic differences in proportional weight were not observed in elite athletes, there was a significant difference between black and white boys, not only in the current study but also in those reported by Krogman (1970) and Meredith (1969). Whether this is indicative of a greater incidence of obesity in the white sample or undernutrition among the Nigerian boys is difficult to determine. Given that proportions of linear, bony measurements have never been shown to be altered by fluctuations in body mass, even in extreme cases of semi-starvation (Evelith and Tanner 1976, Tanner 1978), differences in weight between the black and white boys would not be expected to have any bearing on other proportionality differences observed in this study.

Perhaps due to the difficulty of selecting an appropriate denominator, few attempts have been made previously to study proportional differences in widths of the trunk among children, although mean black and white values for children without a correction for size have been reported by Evelith and Tanner (1976), Krogman (1970) and Meredith (1969). While Krogman (1970) concluded that there were no differences in transverse measurements of the trunk between black and white boys, black means for hip width were consistently smaller than white means both in Meredith's (1969) mixed sample of boys and girls and in Evelith and Tanner's (1976) comparison of boys from the United Kingdom and Nigeria (elite). The fact that the latter two groups were similar in stature indicates that mean differences in biiliocristal width would probably translate into phantom z-value differences, as well; with black boys being proportionally smaller than white boys. Therefore, the results of the current study are in general agreement with comparisons of proportionality characteristics of transverse trunk measurements reported previously.

Differences in both arm and leg length between black and white children have been reported by Meredith (1969) and Krogman (1970). Among eight-year-old children from various parts of the world, Meredith (1969) found the U. S. black children to have the longest arm length of all; approximately 2 cm. longer than the U. S. white children. Proportionality assessments of limb lengths were not attempted by Meredith (1969).

Krogman's analysis (1970) distinguishes between the sexes and for the boys (ages 7–14 years) consistent differences were observed between groups means in limb lengths. Black males had consistently longer limbs than white males, except at age 10 years when white means appear to catch-up to black means for a year or two; presumably due to an early growth spurt by the white boys. The same phenomenon appears to occur in our sample when only the means are considered (*Table 1*). Yet, Phantom z-scores even at those ages (*Figures 2g* and *2h*) continue to show distinct differences in proportional limb length, with the black groups having a marked length advantage.

Although arm length was measured differently in each sample, a recent study in this laboratory demonstrated that these two methods of measurement produced no significant systematic differences in arm length values (personal communication). Also, since the criterion anthropometrists in both studies learned their techniques in the same laboratory at Simon Fraser University, there should be little, if any, systematic error with respect to the other variables included in this study.

Since leg length and sitting height account for stature, it is not surprising that these two variables are the most widely used to assess human proportionality. The results of the current study, along with those reported by others (Krogman 1970, Malina, Brown and Zavaleta 1987, Martorell et al. 1988), show clearly that a relatively short sitting height and a relatively long leg length is a general characteristic of black males of all ages in comparison to white males.

In conclusion, the ethnic dimorphism which was observed in adult males (Ross 1978) has been shown to exist in prepubescent boys, as well; confirming previously reported ethnic differences among children in an entirely novel way. The Phantom stratagem implemented here has a number of advantages over ratios in the assessment of human proportionality. Firstly, it allows for the comparison of variables which differ dimensionally, e.g. weight (d = 3) versus a length (d = 1), since phantom z-values are given in a geometrically corrected form. Secondly, the Phantom stratagem can identify degrees of departure between variables. Taking eight-year-olds as an example (*Figure 2e*), we can state in absolute terms that the black-white difference in proportional arm length is greater than the difference in proportional leg length. Thirdly, the method can be used to make comparisons across age and sex categories, since all values, whether male or female, young or old, are given with respect to the same standard. Finally, phantom z-values can be directly compared from one study to the next whenever they are reported, allowing for a standardized approach to the study of human proportionality.

Summary

This study clearly demonstrates that there are consistent proportional differences between black and white males at all ages in biiliocristal width, upper body length and limb lengths. In agreement with virtually every study which has examined these morphological features, black males have narrower hip widths, shorter upper body lengths and longer limb lengths than white males. The Phantom stratagem for the assessment of human proportionality is recommended for future investigations.

Acknowledgements: Special thanks to *Grace Akintunde* for her faithful assistance in the measurement sessions, to *Mary Ross* for the skinfold calipers and to the people at the International Institute of Tropical Agriculture (IITA), who provided assistance in the form of transportation and computer services.

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Received 28 January, 1992.

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MEGEMLÉKEZÉS

Anthrop. Közl. *33;* 313. (1991)

DR. TÓTH A. TIBOR
1929 — 1991

Dr. Tóth Tibor a biológiai tudomány doktora, a Természettudományi Múzeum Embertani Tárának igazgatója 1929 január 5-én Szolnokon született. Elemi iskolába Szolnokon járt, gimnáziumi tanulmányait Mezőtúron folytatta. 1947 és 1952 között a budapesti Eötvös Loránd Tudományegyetem Természettudományi Karának volt hallgatója. A 3. évfolyamot a bukaresti C. I. Parhon Tudományegyetemen végezte. 1952-ben muzeológus szakos oklevelet kapott. 1951—1954 között a Múzeumok és Műemlékek Országos Központjának előadójaként dolgozott, majd 1954 és 1958 között a moszkvai Lomonoszov Egyetem Embertani tanszékének aspiránsaként végzett antropológiai kutatásokat. 1958-ban "Az arckoponya horizontális profilozottsága a magyar nép származásával kapcsolatban" című értekezésével a biológia tudomány kandidátusa, 1978-ban "Magyarország lakosságának szomatológiája és paleoantropológiája" című disszertációjával a biológia tudomány doktora tudományos fokozatot szerezte meg. Mindkét disszertációját a moszkvai Lomonoszov Egyetemen védte meg.

Időközben 1960-ban az Eötvös Loránd Tudományegyetemen egyetemi doktori címet kapott.

1958 és 1962 között a Természettudományi Múzeum Embertani Tárában tudományos főmunkatárs, 1962-től 1965-ig osztályvezető-helyettes, 1965-től 1990 december 31-ig a Tár igazgatója volt. Nyugdíjba vonulása után is aktívan dolgozott, 1991. október 3-án szívinfarktus miatt bekövetkezett haláláig.

Tudományos érdeklődése az emberszármazástan, a morfológia, az etnikai és főként a történeti embertan területére terjedt ki. Mint a korábbi Szovjetunióban végzett aspiráns, elsősorban a szovjet antropológusok által alkalmazott vizsgálati módszerek felhasználásával, a magyar nép etnogenezisének elemzésével és a honfoglaláskori magyarság kutatásával foglalkozott. Ezzel kapcsolatban tanulmányozta a magyarországi avarkori leleteket is. A volt Szovjetunió területéről származó bronzkori leleteket, mongóliai paleoantropológiai szériákat is közölt. Fokozott figyelmet fordított a csontmorfológiai evolúciós problémákra és az egyes jellegek diagnosztikai jelentőségére. A magyar antropológiai kutatásokba ő vezette be a mongolid és europid leletek arcprofilozottság alapján történő megkülönböztetését.

Orosz nyelvtudása és számos szovjetunióbeli tanulmányútja alapján jól ismerte a szovjet antropológiát. Tapasztaltairól, a szovjet antropológusokról és munkásságukról számos cikkben emlékezett meg.

Aktívan részt vett a magyar tudományos közéletben. 1959-től haláláig tagja volt a Magyar Tudományos Akadémia Antropológiai Bizottságának, 1964-től az Anthropologiai Közlemények, 1965-től a Természettudományi Múzeum Évkönyve Szerkesztőbizottságának, 1965-től szerkesztette az Anthropologia Hungarica című folyóiratot. Több éven át részt vett a Tudományos Minősítő Bizottság Biológia I. szakbizottságának munkájában.

Tóth Tibor alapos munkával tanulmányozta a feltárt embertani leleteket, és kétségtelen érdeme volt abban, hogy a Természettudományi Múzeum Embertani Tára ma jelentős számú hiteles emberi csontlelettel rendelkezik. Száznál több publikációja magyar, orosz, angol, francia és német nyelven hazai, szovjet, mexikói, finn, NDK-beli és olasz szakfolyóiratokban jelent meg. Ezekkel kétségtelenül beírta nevét a magyar antropológia történetébe.

Farkas L. Gyula

Anthrop. Közl. 33; 314. (1991)

A MAGYAR BIOLÓGIAI TÁRSASÁG EMBERTANI SZAKOSZTÁLYÁNAK MŰKÖDÉSE AZ 1991. ÉVBEN

271/1. szakülés, 1991. március 11.

BODÁNSZKY HEDVIG — ÁGFALVI RÓZSA: Coeliákiás gyermekek testi fejlődése.
ÖRLEY JUDIT — HAJDÚ JÚLIA: Az obesitas gyermeknőgyógyászati következményei.

A Pediátriai-Antropológiai Szekció vezetőségének megválasztása.

A vezetőség: *elnök:* ***dr. Blatniczky László;*** *titkár:* ***dr. Joubert Kálmán;*** *vezetőségi tagok:* ***dr. Ágfalvi Rózsa, dr. Örley Judit, dr. Buday József, dr. Csoknyay Judit, Hajdú Ilona, Tóth Sándorné.***

272. szakülés, 1991. április 15.

EIBEN OTTÓt köszöntötte a Szakosztály.
HAUSER, GERTRUD (Wien): Dermatoglyphic studies.
KORDOS LÁSZLÓ: A Rudapithecus és az afrikai Hominoideák összehasonlítása: egy kenyai tanulmányút tapasztalatai.

273. szakülés, 1991. május 24.

Az Embertani Szakosztály és a Magyar Gyógypedagógusok Egyesülete Iskolaegészségügyi Szakosztályának közös szervezése Homokon.

SZLANKÓ ISTVÁN: Tiszaföldvár története — dióhéjban.
EIBEN OTTÓ — BARABÁS ANIKÓ — PANTÓ ESZTER: Adatok Szolnok megye ifjúságának biológiai fejlettségéhez és fizikai erőnlétéhez.
BUDAY JÓZSEF: Tiszaföldvár ifjúságának testi fejlődése és testalkata.
KONCZNÉ JOBBÁGY ESZTER — JAKABNÉ VARGA MÓNIKA: Tiszaföldvár ifjúsága a szomatopedagógus szemével.

274/2. szakülés, 1991. november 18.

BUDAY JÓZSEF: Genetikai tényezők az értelmi fogyatékosság etiológiájában.
JOUBERT KÁLMÁN: A csecsemőhalandóság néhány biodemográfiai jellemzője Magyarországon.

*

A Magyar Biológiai Társaság ***dr. Eiben Ottó*** professzort, az Eötvös Loránd Tudományegyetem Embertani Tanszékének vezetőjét "a biológiai szemléletmód terjesztésében hosszú időn át végzett eredményes tevékenységéért" ***Huzella Tivadar díjjal*** tüntette ki (1991. december).

S. É.

KÖNYVISMERTETÉSEK

Anthrop. Közl. 33; 315–318. (1991)

CARTER, J. E. Lindsay — HEATH, Barbara Honeyman: *Somatotyping. Development and Applications.* (Cambridge Studies in Biological Anthropology 5. Sorozatszerkesztők: G. W. Lasker, C. G. N. Mascie-Taylor és D. F. Roberts. — 503 oldal, 86 táblázat, 194 vonalas ábra és 20 fotó. — Cambridge University Press, Cambridge — New York — Port Chester — Melbourne — Sydney, 1990. Ára: £ 80.00 / $ 125.00 — ISBN 0 521 35117 0)

Lindsay Carter és Barbara Honeyman Heath Roll szomatotípus-könyve a nemzetközi humánbiológiai irodalom régóta esedékes és nagyon várt kézikönyve. Sheldon 1940-ben kiadott alapvető munkája (Varieties of Human Physique), majd Parnell 1958-ban publikált könyve (Behaviour and Physique) óta nem jelent meg összefoglaló alapmunka e témakörben.

Amint az közismert, a szomatotipizálás alkalmas módszer arra, hogy az emberi (fenotipikus) testalkatot három komponens alapján leírja. Az *endomorfia* a relatív kövérségnek ("zsírosságnak"), a *mezomorfia* a csontváz és izomrendszer relatív robusztus voltának, az *ektomorfia* a test relatív linearitásának jelzője.

Barbara Heath — Sheldon egykori munkatársa — már 1963-ban felvetette a Sheldon-féle szomatotipizálási módszer módosításának szükségességét. A következő években Lindsay Carterrel együtt összehasonlította a szomatotipizáló módszereket (1966), és kidolgozta a szükségesnek tartott módosításokat (1967). Számunkra kedves magyar vonatkozása is van ennek a kutatómunkának: az 1976-ban Balatonfüreden megrendezett I. Nemzetközi Humánbiológiai Szimpóziumon Barbara H. Heath részletesen beszámolt a Heath — Carter szomatotipizáló módszer alkalmazásáról. Bemutatta, hogyan fejlődtek ki Sheldon módszeréből a Heath — Carter módszer főbb vonásai, hogyan érvényesültek és adaptálódtak azok. Rámutatott a módosítások szükségességére, amelyek egyben módszerük használhatóságát is jelentősen kiterjesztették [lásd: Eiben O. G. szerk., Growth and Development; Physique. Symp. Biol. Hung. 20; 335—347 (1977)].

A jelen könyv tehát már több évtizedes munkán alapul, és a módosított, azaz Heath — Carter-féle szomatotipizáló módszerről is mintegy negyedszázados tapasztalat állt a szerzők rendelkezésére.

A könyv — amelyhez Derek F. Roberts professzor írt előszót — 17 egységből áll. A szerzők Előszavukban tájékoztatják az olvasót arról, hogy mit várhatnak az egyes fejezetektől, a Köszönetnyilvánításban pedig felsorolják mindazokat, akik a szomatotipizálás módszertanához ötleteikkel, megjegyzéseikkel, a készülő könyv egy-egy fejezetének elolvasásával, megvitatásával hozzájárultak a munkához.

Az első fejezet a szomatotipizálás történetét írja le, a testalkat osztályozásának kezdeteitől a Sheldoni "klasszikus" somatotyping módszerig, illetőleg a Heath — Carter-féle továbbfejlesztésig. E fejezet bemutatja a Sheldon-féle módszer gyöngéit, alkalmazásának korlátait (a főleg férfiakra kidolgozott és életkor-függő, 1-től 7-ig terjedő skála stb.). A fejezet jegyzetekkel zárul, amelyek betekintést adnak a szakemberek levelezéseibe, egyes kérdések megvitatásának menetébe. Ezek igazi csemegék a tudománytörténetet kedvelők számára.

A második fejezet a szomatotipizáló módszereket tekinti át Sheldontól kezdve, Hooton, Bullen és Hardy, Cureton, Parnell, Damon, Medford, Petersen munkásságán, a Leuven-i módszeren át a saját, Heath — Carter szomatotipizáló módszerig. Nemcsak tudománytörténetileg, de szakmailag is izgalmas olvasmány ez a fejezet, ahol a szerzők nemcsak leíró módon áttekintik, de egymással is összevetik az egyes módszereket (pl. Parnell versus Sheldon, Sheldon versus Heath — Carter stb.).

A harmadik fejezet a felnőtt férfiak és nők szomatotípusaiban megmutatkozó variációkat mutatja be a világ legkülönbözőbb részeiről publikált és Heath — Carter antropometriai szomatotipizáló módszerrel feldolgozott nemzeti/etnikai mintákon, katonákon, egyetemistákon, időskorúakon stb. A fejezet második része más, azaz nem Heath — Carter antropometriai szomatotipizáló módszerrel feldolgozott szomatotípus-variációkat tárgyalja.

A negyedik fejezet a növekedés, illetőleg az öregedés során végzett szomatotípus-vizsgálatokat mutatja be. A kevés longitudinális és a sok keresztmetszeti növekedésvizsgálat szomatotípus-becslései rávilágítanak a gyermekkorúakon végzett szomatotipizálás nehézségeire.

Az ötödik fejezet a genetikai aspektusokat tárgyalja iker-, illetve családvizsgálatok alapján.

A hatodik fejezet rendkívül bőséges. Mintegy 100 oldalon keresztül ez a fejezet foglalkozik a szomatotípus és a sport és fizikai teljesítmény kapcsolatával. Közismert, hogy ez a szomatotipizáló módszer alkalmazásának egyik legfontosabb, legrégebben művelt, sőt mondhatnánk, leglátványosabb területe. Az olimpiai játékokon végzett szomatotípus-vizsgálatok is igyekeztek választ adni arra a régi kérdésre, hogy a testalkati adottságok milyen kapcsolatban vannak az eredményességgel. A szerzők összegyűjtötték szinte minden létező publikációt az egyes sportágak férfi és női képviselőiről, és így mutatják be az egyes sportágakra jellemző szomatotípust.

A hetedik fejezet az egészség, a magatartás és a foglalkozás oldaláról közelít a szomatotípussal meghatározott testalkathoz. Az egészség—betegség kapcsolat szemszögéből a keringési betegek, az elhízottak, a cukorbetegek, a genetikai rendellenességben szenvedők (Down-, csík-gonád syndroma, növekedési zavarok) stb. szomatotípusát ismerhetjük meg, jelentős részben magyar vizsgálati eredmények alapján. A magatartás, a temperamentum és a szomatotípus kapcsolata, a szomatotípus pszichiátriai vonatkozásai, illetve a bűnözők testalkatára (szomatotípusára) vonatkozó vizsgálatok bemutatása alkotja a fejezet második részét, míg a harmadik a különböző foglalkozású csoportok szomatotípusát írja le. Választ keres a testalkat és a szakmaválasztás összefüggéseire is.

A nyolcadik fejezet az eddigiek ismétlő összefoglalása és új irányzatok felvázolása.

Ezután három függelékfejezet következik. Az első a Heath — Carter szomatotipizáló módszer (photoscopikus, antropometriai, illetőleg antropometriai plusz photoscopikus) tankönyvi, módszertani leírását adja, sok példával, sok képpel. A második függelék az "Analizis" címet viseli. Itt tárgyalják a szerzők a somatochart történeti kialakulását, a bevezetett módosításokat, a három-, illetve kétdimenziós ábrázolást, a leíró és összehasonlító statisztikákat, és említést tesznek a computer-programról. A harmadik függelék egy lista, amely néhány fontosabb publikáció (Tanner — Whitehouse, Atlas of Children's Growth, 1982; Sheldon, Varieties of Deliquent Youth, 1949; Sheldon, Atlas of Men, 1954) fényképanyaga alapján a Barbara Heath által végzett szomatotípus-meghatározásokat sorolja fel. Rendkívül tanulságos ez a függelék mindazoknak, akik komolyan el akarják sajátítani a szomatotipizálás módszerét.

A könyv Glosszáriummal, igen részletes, 36 oldalnyi Irodalomjegyzékkel és Névmutatóval zárul. Nem túlzás azt állítani, hogy a humánbiológiai világirodalom szomatotipizálással foglalkozó dolgozatainak szinte teljes egésze megtalálható e jegyzékben (12 magyar szerző 23 művel van jelen).

A recenzensnek az 1970-es években megadatott, hogy együtt dolgozhatott mindkét szerzővel, amikor néhány hetet töltöttek az ELTE Embertani tanszékén. Az együtt végzett szomatotipizálás a szakmai tanulságok mellett alkalmat adott arra is, hogy megismerkedjék a két kiváló szakember nem teljesen azonos gondolkodásával is, ami szomatotipizálási munkamódszerüket illeti. A könyv megírásának gondolata ekkor már részleteiben is kialakult. A recenzensnek azután 1985-ben Amerikában alkalma volt a könyv egyes fejezeteit még kézirat formájában elolvasni és mindkét szerzővel megvitatni. E nagy szakmai élmény akkor vált teljessé, amikor ezt a kiváló szakmai színvonalon, ám olvasmányos stílusban megírt könyvet is kézbe vehette. A sok ábra, táblázat, fénykép, a didaktikus felépítés segíti az olvasót.

A könyv szép kiállítása, az igényes nyomdai munka a Cambridge University Press-t dicséri. Lindsay Carter és Barbara Heath olyan kézikönyvet adott közre, amely mindazt összefoglalja, amit ma a szomatotipizálásról tudni lehet. Szeretnénk hinni, hogy előbb-utóbb minden érdeklődő szakember könyvespolcára odakerül ez az alapmű.

Dr Eiben Ottó

DAY, M. H.: *Guide to Fossil Man* 4th ed. Cassell, London, New York, Toronto, Hong Kong, Tokyo, Sydney, 1986. 432 oldal, 133 ábrával, táblázatokkal. Ára: £ 25.00. ISBN 0–304–31288–6)

Ez a könyv igazi "Guide" a fosszilis emberleletekhez. Az előző kiadáshoz képest számos lelőhelyről származó csontmaradvány részletesebb, teljesebb leírását adja, és 15 új lelőhely anyagát is tartalmazza.

A könyv három részre tagozódik. A bevezető részben a szerző az anatómiai fogalmakat vázolja fel, és részletesen ír a normál, a nemi és az életkori variációkról, a fogazatról, valamint nomenclaturai és taxonómiai fogalmakat is tisztáz.

A második rész teszi ki a könyv terjedelmének túlnyomó részét. A lelőhelyeket földrajzi régiók (Európa, Közelkelet, Északnyugat-Afrika, Kelet-Afrika, Dél-Afrika, Távolkelet és Óceánia) szerint és országonként sorolja fel. A tájékozódást jó térképvázlatok segítik. Az egyes emberi maradványok részletes morfológiai leírása és metrikus adatai mellett megemlíti a régészeti mellékleteket (eszközök, állatcsontok stb.), és a geológiai, stratigráfiai adatokat, a lelőhely datálását. Ugyancsak megadja az egyes leletek kapcsolódási összefüggéseit, azaz belehelyezi őket a hominid evolúciós vonalba. Minden egyes leíráshoz a vonatkozó irodalomjegyzéket is megadja a szerző. Külön ki kell emelni a kitűnő ábraanyagot, amely ez esetben több, mint egyszerű "illusztráció". Természetesen a vértesszöllősi leletekről is jelentőségüknek megfelelő, részletes leírást olvashatunk.

A könyv harmadik részében Day professzor három rövid esszében tárgyalja az Australopithecus, a Homo erectus és a Neandertal problémát. Hasznosan egészíti ki a könyvet a glosszárium és a tárgymutató.

Öröm kézbevenni ezt a szépkiállítású, rendkívül informatív könyvet, amelyet nem nélkülözhet egyetlen antropológiai laboratórium sem.

Dr Eiben Ottó

NORGAN, N. G. (Ed.) *Human Body Composition and Fat Distribution.* Report of an EC Workshop, London 10—12 December, 1985. (Stichting Nederlands Instituut voor de Voeding, Wageningen, é.n. — A concerted action project on nutrition in the European Community. 250 oldal táblázatokkal, ábrákkal. Ára: US$ 7.00. ISBN 90–70840–16–2)

E tanulmánykötet, az Euro–Nut Report-sorozat 8. kötete, az Európai Közösség Londonban, 1985. decemberében rendezett munkaértekezletének előadásait tartalmazza.

Az elmúlt fél évszázadban a testösszetétel kutatása igen intenzív volt, a testösszetétel ismerete ma számos szakterületen fontos információnak számít: az orvostudomány számos területe, a táplálkozástudomány, a testnevelés- és sporttudomány és természetesen a humánbiológia számára nélkülözhetetlenek az emberi test komponenseinek, az össztestzsírnak és sovány testtömegnek stb. ismerete. Az 1940-es években az izotóptechnika és a testsűrűség mérésének finomítása, az 1950-es években a test össz-káliumtartalmának becslése γ-sugárzás révén, valamint a testzsír becslése gázabszorpciós módszerrel jelentett előrelépést. Az 1960-as években számos egyenletet konstruáltak az össztestzsír és a sovány testtömeg becslésére a testsűrűség alapján. Az

1970-es években a testben levő egyes ásványi anyagok mérése vált lehetővé neutron-aktivációs módszerekkel, majd az 1980-as években az egész test fajlagos vezetőképességét alkalmazták e kutatásokban. Az 1990-es években — úgy látszik — ismét bizonyos egyenletek kerülnek előtérbe. A műszerigényes vizsgálatok mellett azonban a hagyományos antropometriai eljárások, az egyszerű bőr/zsírredő mérő eszközök, az úgynevezett caliperekkel való mérések jelentősége sem csökkent.

Ez az Euro–Nut konferencia ebben a szellemben tanácskozott. Durnin adott áttekintést a testösszetétel és zsíreloszlás mérésének a klinikai gyakorlatban és a rokon szakterületeken meglevő jelentőségéről. A könyv a továbbiakban négy csoportban közli az elhangzott előadásokat.

Az első részben a módszertani problémákat és az alkalmazási lehetőségeket elemzi hat tanulmány. Ezek közül kiemelkedő fontosságú Katch módszertani referátuma, amelyben sorra veszi a kutatás lehetőségeit, és Roche et al. munkája, amelyben a populációs vizsgálatokban alkalmazott módszereket tárgyalja az "antropometria vagy becslés" kérdés jegyében. Clarys és Martin a Brussels-ben végzett "cadaver study" alapján járul hozzá a sovány testtömeg megismeréséhez. További módszertani tanulmányok olvashatók a test víztartalmának méréséről, a testzsír mennyiségének változásáról stb.

Az új módszereket tárgyalja öt tanulmány a második részben, például a neutron-aktivációs analizist és a foton-absorptiot (Burkinshaw), a computer-tomográfiát és a mágneses magrezonanciát (Heymsfield).

A testzsír eloszlását vizsgálja a harmadik rész három tanulmánya. Mueller a testzsír anatómiai eloszlását, illetve annak variációit, Bouchard és Tremblay pedig a testösszetétel és a zsíreloszlás genetikáját tárgyalja, míg Sjöström et al. a különböző testsúly—testmagasság-indexek és a testzsíreloszlás összefüggését és azok egészségügyi következményeit elemzi.

A negyedik rész tanulmányai, Björntorp referátumával indítva, a testzsír és a betegségek kapcsolatát foglalják össze, az anyagcsere- és a szívkoszorúér-betegségekre koncentrálva.

A kötet értékes tanulmányai hasznosan adják közre a testösszetételről az 1980-as évek közepén meglevő ismereteket, és segítenek az eligazodásban a módszertan tekintetében is.

Dr. Eiben Ottó

ROCHE, A. F. (Ed.) *Body-composition Assessment in Youth and Adults.* Report of the Sixth Ross Conference on Medical Research. (Columbus, Ohio: Ross Laboratories. 1985. 109 oldal, táblázatokkal, ábrákkal)

A testösszetétel-kutatás dinamikus fejlődését bizonyítják azok a konferenciák, amelyeket az 1980-as években e témakörben szerte a világon rendeztek. A kutatók örömére, a konferenciák anyaga általában meg is jelenik. Ilyen tanulmánykötet ez is, amelyet Alex F. Roche, a Wright State University és Fels Research Institute gyermekgyógyász professzora szerkesztett. Előszavában kiemeli, hogy a Virginia-állambeli Williamsburg-ban 1984. decemberében megrendezett konferencia célja kettős volt: (1) megvitatni a testösszetétel-kutatás módszereit és klinikai alkalmazási lehetőségeit, és (2) felvázolni a jövőbeni kutatási irányokat.

A konferencia workshop formájában zajlott, a rövid előadásokat azonnali megvitatás követte. A tanulmánykötet is ilyen módon adja közre az anyagot, öt részben. Az első rész előadásai és vitája a testösszetétel zsírszövettel összefüggő problémáit, a második rész a csontvázzal kapcsolatos kérdéseket elemzi, a harmadik rész pedig a sovány testtömeg oldaláról vitatja meg a fő témát. Néhány előadás a sportorvoslás és a betegellátás kapcsolódó problémáit, továbbá a tápláltsági állapot, az immunológia, a gyógyszerhatástan és a közegészségügy egyes kérdéseit kapcsolja a testösszetétel-kutatáshoz.

A konferencia a jövőbeni kutatásoktól azt várja, hogy finomítsák a testösszetételre vonatkozó direkt módszereket, amelyek a klinikai gyakorlatban jól alkalmazhatók, és ugyanakkor olyan értékes információkat adnak, mint a direkt módszerek; mindezeknek a kutatásoknak végső soron az ember jobb teljesítőképességét és egészségét kell szolgálniuk.

A konferencia és annak teljes dokumentációját adó kötet jelentős hozzájárulás a testösszetétel-kutatáshoz.

Dr. Eiben Ottó

FORBES, G. B.: *Human Body Composition. Growth, Aging, Nutrition, and Activity.* (Springer–Verlag, New York, Berlin, Heidelberg, London, Paris, Tokyo, 1987. 350 oldal, 42 táblázat és 92 ábra. Ára: DM 148. — ISBN 3–540–96394–4)

A könyv előszavában a szerző idézi Claude Bernard kifejezését, a "milieu intérieur"-t, a belső környezetet. A testösszetétel-kutatást ugyanis a szerző a belső, értsd: kémiai környezet vizsgálatának tekinti. James Gamble-tól veszi át a "kémiai anatómia" kifejezést. Azt kutatta, milyen változások mennek végbe az emberi test összetételében, vagyis a test belső/kémiai környezetében a növekedés, az öregedés során, illetőleg betegségek vagy megváltozott táplálkozási viszonyok között. Könyvében saját vizsgálatai mellett mindazokat az alapvető elgondolásokat közreadja, amelyek az egészséges vagy beteg ember testösszetételéről információul szolgálnak.

A könyv első fejezete kutatástörténeti bevezetés, a második pedig a testösszetétel-becslés technikai lehetőségeit, vizsgáló módszereit tárgyalja. A következő három fejezet a magzati élettől a csecsemő-, a gyermek- és a felnőttkoron át az öregkorig kíséri végig az ember testösszetételének változásait. A hatodik fejezet a testösszetétel terhesség alatti speciális problémáit veszi sorra. A következő két fejezet a táplálkozás, illetve a fizikai aktivitás hatását elemzi. Külön fejezetet szentel a szerző a hormonális hatásoknak és egy másikat a traumák, illetve betegségek által okozott testösszetételbeli változásoknak.

A zárófejezet a testzsír és a sovány testtömeg kapcsolatának nézőpontjából foglalja össze a könyv anyagát. Rámutat a longitudinális testösszetétel-vizsgálatok nagy szakmai értékére, amellett, hogy a keresztmetszeti vizsgálatoknak is megvan persze a létjogosultsága. Igen részletes, 41 oldalnyi Irodalomjegyzék tájékoztat a további olvasmány-lehetőségekről.

Forbes olyan könyvet adott közre, amelyben "a kíváncsi olvasó böngészhet, a komoly érdeklődő elmerülhet". Ezt segíti a sok informatív táblázat és a gazdag ábraanyag.

Dicséretet érdemel a Springer–Verlag-tól megszokott elegáns kiállítás is.

Dr. Eiben Ottó

FLÜGEL, B. — GREIL, H. — SOMMER, K.: *Anthropologischer Atlas. Grundlagen und Daten.* (Verlag Tribüne, Berlin, 1986. 367 oldal, táblázatokkal, ábrákkal. — ISBN 3–7303–0042–3)

Ez a könyv az NDK-ban végzett interdiszciplináris kutatások alapján adja közre mindazokat az antropometriai és antropológiai adatokat, amelyek a mindennapi élet számos területén értékes információként szolgálnak, a munkahelyek kialakításától a megelőző és gyógyító orvosi gyakorlatig. — A szerzők a berlini Humboldt Egyetem (Charité) Antropológiai Intézetének munkatársai.

A könyv tíz fejezetre tagolva óriási adathalmazt tartalmaz. Az első rész három fejezetben bemutatja az antropológiai normaértékek alkalmazásának és alkalmazhatóságának lehetőségeit. Rövid demográfiai jellemzést olvashatunk az NDK népességéről, az egyedfejlődésről és az alkalmazott antropológiáról.

A második rész a "Normaértékeket" közli, nagyon bőségesen. Két fejezet foglalkozik az alapvető matematikai–statisztikai módszerekkel, az antropometriai vizsgálati technikával, mérőeszközökkel stb., ezután igen bőséges antropometriai program szerint közli, mintegy 150 testméret adatait: középértékeket, szórást, a méret középértékét a testmagasság középértékének százalékában, majd az 5., az 50. és a 95. percentilis értékét, mindezt természetesen a férfi és a női nemre. Az életkor 3 és 64 év között variál; a 3–17 évesek évenkénti bontásban, azután 18–19, 20–24, 25–29, 30–34, . . . 60–64 éves korcsoportokban, végül 15–59 évesek összevontan is. Ez a legterjedelmesebb fejezet. A következő fejezet egy dinamikus antropometriai adattár: a különböző test- és végtagmozdulatokkal elérhető távolságokat, az uralt tér nagyságát adja meg. A hetedik fejezet fiziológiai, légzési és keringési teljesítményadatokat közöl. A nyolcadik fejezet a biológiai korról (skeletalis korról), az érésről, a másodlagos nemi jellegekről, az egyes életkorok pszichés fejlettségi állapotáról tájékoztat, ugyancsak a "norma" adatok alapján. A kilencedik fejezet a testösszetétel jellemzőit foglalja össze, sok fontos bőr/zsírredő adattal, míg a tizedik fejezet dermatoglifiai leírást és néhány ehhez kapcsolódó adatot tartalmaz.

Az alkalmazott decimális fejezetszámozás következetes keresztülvitele nehezen áttekinthetővé teszi a könyvet. Az Irodalomjegyzék rövid, 73 tétel, csupán néhány alapmunkát sorol fel, a legfrissebb 1984-ből való.

A könyv az NDK tudományos könyvkiadásának egyik legutolsó, kétségkívül sikeres darabja.

Dr. Eiben Ottó

BITTLES, A. H. — COLLINS, K. J. (Eds) *The Biology of Human Ageing* (Cambridge University Press, Cambridge, London, New York, New Rochelle, Melbourne, Sydney, 1986. 280 oldal, táblázatokkal, ábrákkal. — ISBN 0 521 30485 7)

Ez a könyv a Society for the Study of Human Biology Symposium sorozat 25. kötete. Az 1984. áprilisában a társaság és a British Society for Research on Ageing közös rendezésében Londonban lezajlott konferencia anyagát adja közre. A szerkesztők — egyben a szimpózium rendezői is — át kívánták tekinteni a két tudományág, a humánbiológia és a gerontológia–geriátria közös problémáit, az interdiszciplináris kutatások eredményeit. Az utóbbi egy-két évtizedben az e területeken felélénkült kutatások indokolták is e törekvést. Az öregedési elméletek, az öregedés genetikája, az életkorok biológiai jelzői, valamint az időskorú népesség demográfiai, szociális, táplálkozási, fiziológiai és klinikai jellemzése alkotta a konferencia, majd a jelen kötet anyagát.

Ha néhány tanulmányt, témát ki kellene emelni az itt közölt 16 közül, meg kell említeni, hogy az öregedés az evolúciós folyamat részének tekinthető, így modellezhető is. E modellrendszerek kritikai elemzése, valamint az információtovábbításban meglevő életkori változások gén-szinten történő elemzése képezi több tanulmány tárgyát. Mivel sok kutató az életkori változásokat szükségszerűen fejlődési folyamatnak tekinti, a prepubertas-pubertaskori érési folyamatokról is olvashatunk egy tanulmányt. Továbbfejlesztve ezt a témát, a szociális tényezőknek (mint iskolázottság, családi állapot) a biológiai életkorra gyakorolt hatását próbálták elemezni amerikai longitudinális vizsgálatok alapján. A történeti antropológia és paleodemográfia oldaláról is vizsgálták a kérdést. A sejtelhalás, a szervek közötti és szerven belüli funkció-differenciálódás az öregedési folyamat része.

Fontos témakör a demográfia: angliai vizsgálatok alapján az elhalálozási adatok és a népesség korösszetétele, amerikai adatok alapján a népesség fertilitási, bevándorlási és mortalitási viszonyai, valamint a szovjetunióbeli kaukázusi időskorú népesség jellemzése (ez utóbbi "Tények és mítoszok" alcímmel) kínál sok fontos információt.

Néhány tanulmány az élettan és a biokémia oldaláról vizsgálja az öregedési változásokat, ideértve a nyugdíjas kort és annak összes járulékos egészségügyi, szociális, pszichológiai stb. problémáját.

Az öregedés-témakör természetéből (és a könyv szép kiállításából) adódóan számítani lehet jelentős érdeklődésre, mind a biológia, mind az orvostudomány legszélesebb köreiből.

Dr. Eiben Ottó

TARTALOM — CONTENTS

Papers presented at the Fifth International Symposium of Human Biology, Keszthely, 1991

Other Original Papers — Eredeti közlemények

Obituary — Megemlékezés

Folytatás a borító 2. oldaláról

6. A táblázatok címeit, az ábraaláírásokat, a táblák címeit és azok minden szöveges részét két példányban külön is mellékelni kell a kézirathoz az idegen nyelvű fordításhoz.

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, akár a szöveges részben, akár a táblázatok vagy ábrák elkészítésénél. 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 szerkesztőbizottság nem fogad el.

A kéziratokat a szerkesztő címére kell beküldeni, aki a tanulmány beérkezését visszaigazolja. A közlésről – a lektori vélemények alapján – a szerkesztőbizottság 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 50 db. különlenyomatot adunk. Ennek előfeltétele, hogy a szerző a kézirattal együtt pontos címét (irányítószámmal) és személyi számát is bejelentse a szerkesztőnél.

A szerkesztő címe: DR. EIBEN OTTÓ, 1088 Budapest, Puskin u. 3. ELTE Embertani Tanszéke.

A kiadvány előfizethető és példányonként megvásárolható:
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