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PHYSICAL DEVELOPMENT AND OBESITY IN CHILDREN IN THE BÓDVA VALLEY

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Abstract

The study reports some features of the physical development and the frequency of obesity among children in the Bódva valley (in Borsod-Abaúj-Zemplén County, North Hungary). The investigations involved 340 children, aged 7-15 yr of Gypsy or Hungarian ethnicity. The distribution of trait variations (stature, weight, and triceps, biceps, subscapular and suprailiac skinfold thicknesses) were studied by means of regression analysis, Box's test and the t-test (with LEVENE's test). The prepuberty-puberty sex differences and the frequency of obesity were estabilished.

Key words: children's development, sex differences, obesity, BMI

Introduction

The physical development of children is determined by endogenous and exogenous factors. Endogenous factors involve primarily the genetic characters (SUSANNE, 1977; MUELLER, 1983), which give potential bases for the growth and sexual maturation of the individual. Which of these possibilities are expressed and appear genotypically is determined by the exogenous environmental factors. From among the natural and social environmental factors (WOLANSKI, 1988), we emphasize here the socio-economic assets, laying stress on the role of the family and the quality of life (JOHNSTON et al., 1980; PAP et al., 1996).

Outstandingly important factors are the social status and life style of the children (primarily the nutritional habits), which play a decisive role in the evolution and arrangement of the fat tissues. One unfavourable result of overfeeding is the development of obesity, which may have undesirable consequences from a pathological aspect, e.g. the development of a diabetic state, bilestones or hypertension (BÍRÓ, 1990).

Obesity involves a pathologically increased fat content in the organism. Its existence is demonstrated by deviation of the body mass from that which normal for the given stature, age, constitution and racial qualities (MAGYAR, 1972; EIBEN, 1977; FARKAS, 1986). Its examination is most frequently based on the determination of skinfold thickness in various regions of the body. Obesity can be interpreted from various points of view. The cases can be grouped by means of indices, the basis of which are the weight and stature data. It may be calculated in various ways; accordingly, the categories are also based on different criteria:

1. The BROCA index and its modified variant (SZOLLÁR, 1988):
   weight (kg) = stature (cm) – 100, or
   (for females) stature (cm) – 100 – 10%
   (for males) stature (cm) – 100 – 5%
2. The obesity index (OKAYASU et al., 1994):
   found weight – standard weight (based on sex and stature)/standard weight
3. The LIVI index (KNUSSMANN, 1988):
   $[\sqrt[3]{\text{weight (g)}} / \text{stature (cm)}] \times 10$
4. The body mass index (KNUSSMANN, 1988) (BMI, QUETELET index, KAUPSCHER index):
   weight (g) / stature^2 (cm)
   weight (kg) / stature^2 (m) (KEYS et al., 1972; GYENIS, 1994)
5. Use of percentiles (WINICK, 1975)

Material and methods

The examinations involved 340 children, aged 7-15 yr, of Gypsy (76 boys and 67 girls) or Hungarian (96 boys and 106 girls) ethnicity. This is the age group that reacts most sensitively to the changes in the environmental factors. An examination of their metrical characters can therefore provide a picture of their socio-economic status. Sampling was performed at two places: Szalonna and Bódvaszilas (Bódva valley, Borsod-Abaúj-Zemplén County, North Hungary). The children were classified into two large groups: the group of Gypsy children, and the Hungarian children from Szalonna and Bódvaszilas.

The children were divided into only four age groups, since the numbers of children in the individual age groups were too low to provide statistically reliable data for intrapopulational analysis: age group I: 7-8 yr; age group II: 9-11 yr; age group III: 12-13 yr; age group IV: 14-15 yr. These corresponded to the start of sexual maturation, abrupt increases in the metrical characters and the menarcheal age. Detailed statistical analyses were performed by age groups, sexes and ethnic groups. The medians for menarche for European girls lie in the range 12-14 yr. As concerns the sexual maturation of Hungarian girls in the past 30-35 years, the reported median values were between 12.77 and 13.86 yr (DANKER-HOPFE, 1986. cit. EIBEN, BODZSÁR, FARKAS, PANTÓ, THOMA).

Six traits were examined: weight, stature and four skinfold thickness values: on the biceps, the triceps, the subcapula and the suprailiaca. For data regression analysis, BOX's test and the t-test (with LEVENE's test) were used. Processing was performed with the help of the SPSS/PC$^+$ program packet.

The different weight categories were established via the stature - weight relation studies (PAP et al., 1996), the results of the regression analysis of weight, the four skinfold thicknesses and the analysis of the median-interquartile ranges. Evaluation was performed with the help of the body mass index (weight (g)/stature^2 (cm)), the classification being based on the following categories :

very lean	≤1.80
lean	1.81-2.14
medium	2.15-2.56
stocky	2.57-3.04
obese	≥3.04

Results and discussion

Because of the lack of space, we shall omit a detailed presentation of the values obtained with the t-test (LEVENE'S test). The descriptive statistical analysis is illustrated for age group IV of the Hungarian and Gypsy children (see Tables 1 and 2). In the first and second age groups, there was no significant difference between the sexes in any of the traits in either ethnic group. In the first age group, the difference in the skinfold thickness on the triceps approached the significance level $p=0.05$ for the Hungarian children. In age group III, the increase in the metrical characters of the girls indicated the start of puberty and the beginning of sexual maturation; relative to the boys, significant differences can be demonstrated in all six traits, to the advantage of the girls ($p<0.05$ for the weight, stature and skinfold thickness on the biceps, and $p<0.01$ for the triceps, subscapular and suprailiac skinfold thicknesses). For the Gypsy children, only the subscapular skinfold thickness showed a significant difference ($p<0.05$), again to the advantage of the girls. Age group IV presents further changes: the boys reach the period of puberty, and there is an abrupt growth in stature and consequently in weight, whereas the skinfold thicknesses do not exceed the values for the girls. For the Hungarian children in the fourth age group, all differences were significant, except for weight. For the boys the stature ($p<0.01$), and for the girls the skinfold thicknesses ($p<0.01$ in all four cases) were higher. For the Gypsy children, neither the stature nor the weight differed significantly. On the other hand, very considerable differences in skinfold thickness were to be found, to the advantage of the girls ($p<0.01$).

Table 1. Descriptive statistics of the body measurements and skinfold thickness in Hungarian boys and girls in the Bódva valley (age group IV).

Variables	Sex	Mean	SD	SE of mean	Mean diff.	LEVENE's test	T-value	2-Tail sig.
Stature	Boys	165.7222	10.535	2.027	6.4279	F=2.861	2.66	.010
	Girls	159.2943	8.477	1.433		P= .096		
Weight	Boys	51.7222	10.015	1.927	3.3508	F=4.250	1.49	.142
	Girls	48.3714	7.713	1.304		P= .044		
Subscap. skinfold	Boys	7.4259	2.468	.475	-3.7169	F=5.148	-3.51	.001
	Girls	11.1429	5.053	.854		P= .027		
Suprail. skinfold	Boys	5.9630	2.410	.464	-4.5799	F=5.596	-4.10	.000
	Girls	10.5429	5.403	.913		P= .021		
Triceps skinfold	Boys	7.8889	3.479	.670	-5.1397	F=3.234	-5.31	.000
	Girls	13.0286	3.996	.675		P= .077		
Biceps skinfold	Boys	4.8704	1.929	.371	-4.8153	F=5.163	-5.54	.000
	Girls	9.6857	4.178	.706		P= .027		

In the course of data processing, the changes in each skinfold thickess were examined as a function of weight by means of regression analysis. This method is suitable for demonstrating the increases in the various metrical characters, the rate of increase and the relationship between the increases in the two traits. With boxplot diagrams, the changes in the skinfold thicknesses were examined relative to the increase in age. Figures 3 and 4 reveal not only the changes in the median values, but also the width and arrangement of the interquartile range, as well as the maxima, the minima and the extreme cases.

Table 2. Descriptive statistics of the body measurements and skinfold thickness in Gypsy boys and girls in the Bódva valley (age group IV)

Variables	Sex	Mean	SD	SE of mean	Mean diff.	LEVENE's test	T-value	2-Tail sig.
Stature	Boys	160.4100	9.551	3.020	7.0827	F= .034	1.72	.102
	Girls	153.3273	9.343	2.817		P= .856		
Weight	Boys	48.8500	10.236	3.237	3.5318	F=2.254	.93	.364
	Girls	45.3182	7.008	2.113		P= .150		
Subscap. skinfold	Boys	7.0000	1.414	.447	-5.2727	F=8.771	3.33	.004
	Girls	12.2727	4.819	1.453		P= .008		
Suprail. skinfold	Boys	5.4000	1.776	.562	-5.4182	F=7.221	4.03	.001
	Girls	10.8182	3.894	1.174		P= .015		
Triceps skinfold	Boys	6.5000	1.269	.401	-7.4091	F=9.437	6.45	.000
	Girls	13.9091	3.419	1.031		P= .006		
Biceps skinfold	Boys	5.0000	1.414	.447	-4.5455	F=1.590	5.39	.000
	Girls	9.5455	2.296	.692		P= .223		

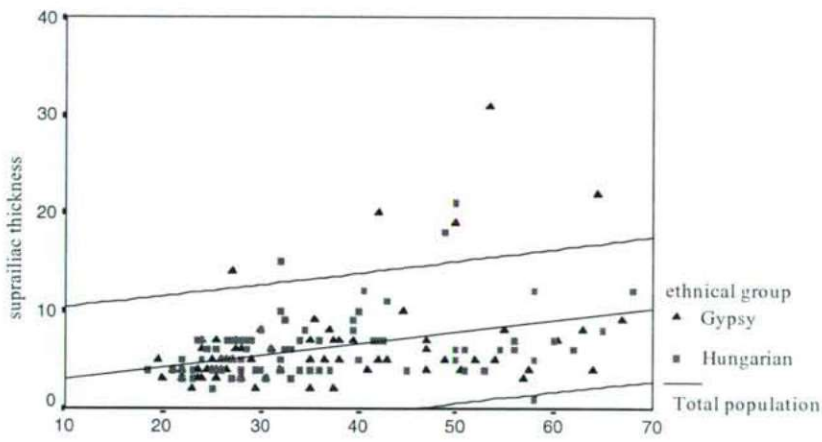

Fig.1. Linear regression of suprailiac skinfold thickness vs. weight of boys in the Bódva valley (all age groups).

The skinfold thickesses measured at four parts of the girls' bodies increased together with weight (e.g. Fig. 2; $Y'_H = 0.27x - 1.36$; $Y'_G = 0.37x - 4.30$); nevertheless, the gradient of the regression line indicating the correlation between the increase in the two traits was less steep than that obtained for the growth relation for stature – weight. In the case of the girls, with the help of the boxplot diagram (Fig. 4), an increase could be demonstrated for the growth of thickness of the suprailiac skinfold thickness with age in both ethnic groups, whereas no such unequivocal tendency was found for the other skinfold thicknesses. The increase in skinfold thickness was hardly influenced by rise in weight for the boys (e.g. Fig. 1; $Y'_H = 0.09x + 2.81$; $Y'_G = 0.15x + 0.94$). In fact, on the biceps and triceps the gradient of the linear regression line approximated to 0, which means that the weight had to or only a very slight influence on the change in skinfold thickness. This was confirmed by the boxplot analysis results (Fig. 3). The values of the median are consistently similar, independently of age, and are arranged nearly linearly. The interquartile ranges are extremely narrow, probably because the trait does not show great individual variability.

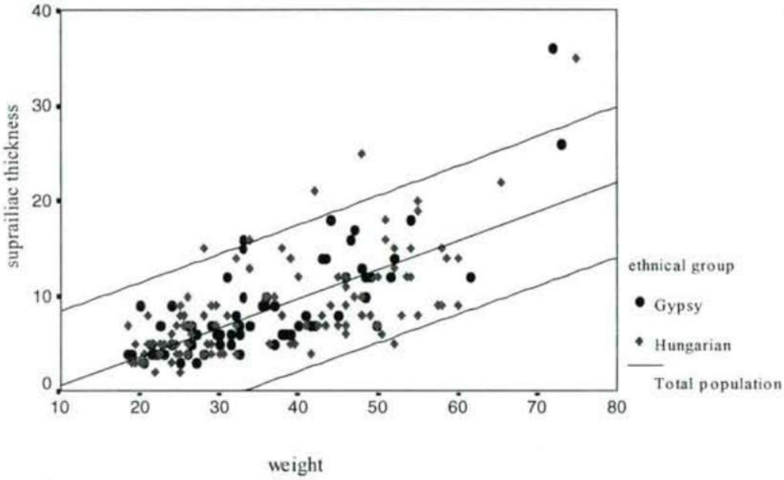

Fig. 2. Linear regression of suprailiac skinfold thickness vs. weight of girls in the Bódva valley (all age groups).

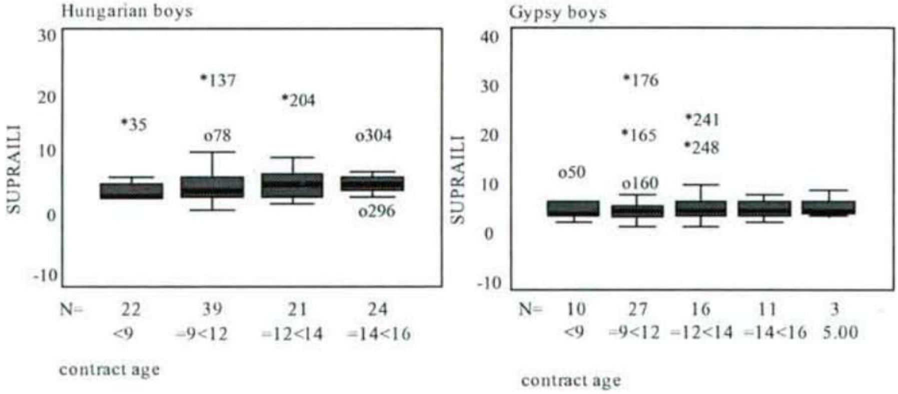

Fig. 3. Boxplot presentation of suprailiac skinfold thickness of boys in the Bódva valley.

Through endogenous and exogenous impacts the individual becomes a carrier of individual characters. In addition to data processing at the microregion and population levels, therefore the management of data at the individual level is inevitable, since this is the only possibility of selecting the obese children, and their data can be interpreted only in this way. The pinpointing of potentially obese children was successful with the joint application of the above-mentioned methods. For assessment, the body mass index was used. Only those were regarded as obese who belonged in the two top body mass index categories (stocky or obese), and they were involved in the percentual evaluation. Table 3 reports the frequency data broken down into ethnic groups, sexes and age groups. None of the Hungarian boys belonged in the two body mass categories mentioned. In the other cases, each percentual value means one child among those of the given age. In the overwhelming majority of cases, these subjects fell into the stocky category, with the exception of a 16-year-old Gypsy girl, who was in the fifth (obese) group.

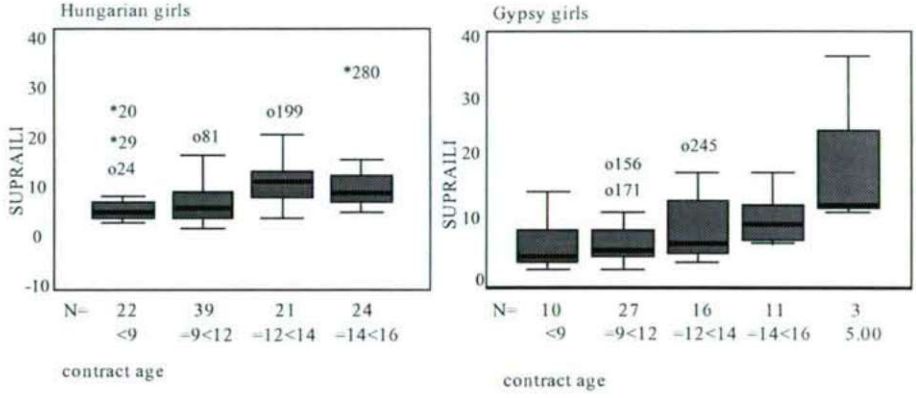

Fig. 4. Boxplot presentation of suprailiac skinfold thickness of boys in the Bódva valley.

Conclusion

The statistical evaluation of the data on the Bódva valley children revealed that weight, in general, has no all or only a slight influence on the changes in the skinfold thickness values. This can mainly be observed in the case of boys. It is correlated with the circumstance that the age of the children does not notably affect the thicknesses of the skinfolds. For the girls, the thickness of the suprailiac skinfold is most markedly dependent on age, due to the start of sexual maturation, which triggers the process of feminine development, and the evolution of the secondary sex characters, which involves the accumulation of fat tissues around the hips. The t-test was highly suitable for following the presence of sex characteristics from childhood through prepuberty up to the beginning of puberty. The period of puberty falls between 12 and 13 years for girls, whereas for boys there is a delay of about 2-3 years. The comparisons in age group IV demonstrate that the skinfold thickness is significantly greater in every case for girls than for boys, and this difference as a sex characteristic probably persists after puberty. The increase in the thickness of the suprailiac skinfold results in the development of the centralized fat tissue pattern.

Table. 3. Frequency of obesity in the Bódva valley

	Hungarian boys			Gypsy boys			Hungarian girls			Gypsy girls		
	All	Obese	Obese	All	Obese	Obese	All	Obese	Obese	All	Obese	Obese
Age	n	n	%	n	n	%	n	n	%	n	n	%
7	3	-	-	3	-	-	7	1	14.28	1	-	-
8	11	-	-	7	-	-	15	-	-	9	-	-
9	13	-	-	10	-	-	16	-	-	7	-	-
10	18	-	-	13	-	-	10	-	-	6	-	-
11	14	-	-	8	1	12.5	13	1	7.69	14	-	-
12	4	-	-	8	-	-	12	1	8.33	11	-	-
13	11	-	-	14	1	7.14	9	-	-	5	1	20
14	12	-	-	7	-	-	17	1	5.88	7	-	-
15	5	-	-	3	-	-	7	-	-	4	-	-
16	0	-	-	3	-	-	0	-	-	3	1	33.3
All	91	-	0%	76	2	2.63%	106	4	3.77%	67	2	2.98%

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References

BÍRÓ, GY. (1990): Nutrition and cardiovascular risk: the Hungarian experience. - Acta Cardiologica *45*, 3-14.

DANKER-HOPFE, H. (1986): Menarcheal age in Europe. - Yearbook of Phys. Anthropol. *29*, 81-112.

EIBEN, O. (1977): Hungarian investigations concerning growth and development and the variation of physique. In: EIBEN, O. (ed.): Growth and development; Physique. - Symp. Biol. Hung. *20*, 11-15.

FARKAS, GY. (1986): Délalföldi 10-18 évesek testi fejlettsége és a leányok menarchekora. - Budapest (DSc thesis).

GYENIS, GY. (1994): Az obesitas gyakorisága magyar egyetemi hallgatókon. - Anthrop. Közl. *36*, 59-67.

KEYS, A., FIDANZA, F., KARVONEN, M. J., KIMURA, N. and TAYLOR, H. L. (1972): Indices of relative weight and obesity. - J. Chron. Dis. *25*, 329-343. (cit. in: GYENIS, 1994)

JOHNSTON, F. E., SCHOLL, T. O., NEWMAN, B. C., CRAVIOTO, J. and DE LICARDIE, E. R. (1980): An analysis of environmental variables and factors associated with growth failure in a Mexican village. - Hum. Biol. *52*, 627-637.

KNUSSMANN, R. (1988): Somatometrie. In: KNUSSMANN, R. (ed.): Anthropologie. Handbuch der vergleichenden biologie des Menschen. - Gustav Fischer, Stuttgart, New York, 232-283 pp.

MAGYAR, I. (1972): Obesitas. In: ÁKOS, K. and RÉVÉSZ, Gy (eds): Orvosi lexikon. - Akadémiai Kiadó, Budapest, 758-759 pp.

MUELLER, W. H. (1983): The genetics of man fat. - Yearbook of Phys. Anthropol. *26*, 215-230.

OKAYASU, T., AYA, H., OBARA, M., OKABE, A. and ARASHIMA, S. (1994): Longitudinal analysis of obesity in Japanese children and youth. In: EIBEN, O. (ed.): Humanbiol. Budapest. Auxology' 94. Children and youth at the end of the 20th century. - Budapest, 549-553 pp.

PAP, M., SZABÓ, GY. and GÖNCZY-SZABÓ, T. (1996): Population-biological feature of human populations, physical development of children and environmental effects. - 10th Congress of the European Anthropological Association. Program Abstracts. Brussels, 54 p.

SUSANNE, C. (1977): Heritability of anthropological characters. - Hum. Biol. *49*, 573-580.

SZOLLÁR, L. (1988): Az elhízás. In: HÁRSING, L. (ed.): Kórélettan. - Medicina, Budapest, 211-228 pp.

WINICK, M. (1975): Childhood obesity. - John Wiley & Sons.

WOLANSKI, N. (1988): Ecological aspects of the growth and development of man. - Colleg. Anthrop. *12*, 1-12.