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The Relationship between Body Structure and the Socio-Economic Status in Hungarian Children and Adolescents

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A B S T R A C T

Among the numerous factors that influence the pattern of children's growth and development there are factors of the changeable socio-economic environment. The inequalities among the socio-economic strata in the Hungarian society have increased during last decades. The main objective of the study was to examine the body structure of children and adolescents living in different socio-economic backgrounds. The subjects of the present paper (9479 boys, 9304 girls) were examined in the 2nd Hungarian National Growth Study 2003–2006. Body structure was assessed by some absolute body dimensions, BMI, body composition and body shape indices. Children were grouped into relatively good, average and poor socio-economic subgroups by considering the education and occupation of the parents as well as the number of children in the family. Significant differences were found in the body structure of children varying in the socio-economic background: the better the socio-economic conditions the higher stature in both genders, while the lower relative fatness was found only in pubertal girls. The prevalence of unhealthy nutritional statuses (both underweight and overweight/obese) was significantly lower in children living in better socio-economic conditions in both genders. Differences that were found in the body structure of children living in different socio-economic backgrounds emphasize the importance of using reference growth values layered also to socio-economic strata for screening nutritional status in childhood and adolescence.

Key words: *2nd Hungarian National Growth Study (2003–2006), socio-economic background, nutritional status, body composition, somatotype*

Introduction

It is evidenced by auxological surveys that each healthy child follows the same growth pattern from birth till sexual maturity independently from gender or the genetic origin[1]. Nevertheless, the rate of growth, as well as the timing and duration of the developmental phases are population-dependent and determined by environmental factors. Thus the growth pattern of children changes dynamically over time by following the environmental changes. The direction and the rate of this change in the growth pattern – that is called secular trend – is generally accepted as an indicator of both the biological status of the studied populations as well as the changes appeared over time in the socio-economic status of the subgroups or strata in the populations[2].

A basic theorem of the discipline termed epidemiological auxology that had developed by utilizing the research data on the relationship between socio-economic environment and child growth or maturation is that the differences in the growth patterns of the various generations, respectively of the children of subpopulations living under different socio-economic conditions are primarily due to socio-economic factors[1,3–11]. The epidemiological auxology does not deal with the processes of growth and maturation per se but uses them as means to unveil the socio-economic status of communities, in particular when there are considerable economic differences between them[2,12–13]. It is epidemiological auxology that by analyzing child growth can provide detailed data on the socio-economic status of a larger community or on the social inequalities within a population. This has been the reason why the WHO[14] regards the growth data of children and juveniles as the most suitable indicators in

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describing the nutritional, hygienic and health status of communities. This of course assigns particular importance to a regular monitoring of childhood and young-age growth as well as to regional comparisons since these are the main sources of data on the factors of suboptimal health and thereby the logical foundation of elaborating social policy.

Significant shifts have occurred in the structure of diet, physical activity patterns, and as a summation of these lifestyle changes in the nutritional status of human populations in the developed societies due to technological changes (e.g. the price of food has lowered, the amount of physical activity required at work and in daily activity has reduced in the last century[15–17]. These trends manifested in the lifestyle of Hungarian children and adolescents as well, i.e. in the increasing prevalence of unhealthy eating and physical inactivity patterns, and increased body fatness[18–20].

The influences of the macroclimate (e.g. the type of the region's settlements, the grade of urbanization, medical and educational resources and institutions, professional composition, regional social policy) shape the physical and mental exfoliation of children, and all of these influences can reach the children through their environment and their family. As microclimate it is the family that mediates the economic functions and provides the care so essential for the physical existence of the child. The role of the micro-environmental factors, i.e. parental attitudes, the level of parental education, etc. and as a summation of these components the socio-economic status of the family, in shaping health behaviour (e.g. eating and physical activity habits) has been evidenced by numerous health behaviour related auxological studies[21–29]. The commonly used socio-economic status measures are income, consumption expenditure, household composition, parental education and occupation. There are additional factors for classifying economic standing, which can vary by the economic status of the countries (e.g. housing tenure, household ownership of durable assets, infrastructure and housing characteristics – source of water, sanitation facility, etc.)[30,31].

Taking into account all these evidenced influences of environmental factors on somatic development, the basic aims of the present research were to study (1) if essential differences do exist in the body structure of children living in different socio-economic backgrounds, (2) if such differences do exist, then in which stage of human life cycle the differences are the most pronounced, and (3) which indicators of body structure do have the largest environmental dependency.

Subjects and Methods

The subjects of the present study aged between 3–18 years (9479 boys and 9304 girls, Table 1) and represented a randomly selected subsample (for monitoring the factors of the socio-economic background and for analyzing their interactions with the biological status of children) of the 2nd Hungarian National Growth Study 2003–2006[32].

The anthropometric measurements were performed by using standardized techniques (IBP recommendations[33]) and standard anthropometric measuring devices.

Body development of children was assessed by using absolute body dimensions (body height and weight), relative body mass (BMI), and body composition indices. The development of the skeleto-muscular system was estimated by the relative/corrected upper arm muscle area (CAMA):

$$\text{CAMA (cm}^2\text{)} = (170.18/\text{H}) \times (\text{MUAC}/2\pi - \\ - (\text{ST}+\text{SB})/40)^2 \times \pi$$

while the body fatness was assessed by the stature-adjusted sum of 8 skinfold thicknesses (SKF) – skinfold thicknesses were weighted to take into account their variation ranges and their location on the body:

$$\text{SKF} = (170.18/\text{H}) \times [2.6\text{SFa} + (2.3\text{SB}+1.7\text{ST})/2 + \\ + (1.6\text{SSs}+1.5\text{SCh})/2 + (1.2\text{SSi}+1.2\text{SA})/2 + 1.2\text{STh} + \\ + 1.4\text{SC}]$$

where 170.18 is the estimated stature (cm) of the human unisex phantom[34], H: body height (cm), MUAC: mid upper arm circumference – relaxed (cm), ST and SB: thicknesses over the triceps and the biceps, SFa: mid-forearm skinfold thickness, SSc: subscapular skinfold thickness, SCh: chest skinfold thickness, SSi: suprailiac skinfold thickness, SA: abdominal skinfold thickness, STh: mid-thigh skinfold thickness, SC: calf skinfold thickness (skinfold thicknesses are in mm).

Nutritional status was assessed by BMI (kg/m^2), children were grouped into the BMI categories »underweight«, »normal«, »overweight« and »obese« by using the age-dependent cut-off points recommended by Cole and his colleagues[35,36].

Individual somatotypes were estimated by the Heath-Carter anthropometric method[37]. Components were calculated by using the regression equations suggested by Carter[38]. Tridimensional somatotypes were represented by somatoplots in the two-dimensional somatochart[37].

TABLE 1
CASE NUMBERS BY AGE AND GENDER

	Age (years)																
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Boys	292	413	503	482	483	593	634	619	686	724	683	588	745	785	686	563	9479
Girls	303	382	461	497	518	640	641	647	742	779	724	567	700	647	523	533	9304

Children's socio-economic background was surveyed by using questionnaires. There are some methodological difficulties connecting with socio-economic status estimation, e.g.: (1) The commonly used determinants of the socio-economic status do not capture all of the effects of family background[39]. (2) Sometimes it is quite difficult to use these indicators in the estimations, e.g. it is difficult to fully and accurately measure income[39–41]. (3) The influence of these factors on for example children's growth pattern can not be studied independently, there are many interactions between them. (4) Differences in growth pattern of children associated with social class and ethnicity can many times mask each other in such developing countries, in which for example significant differences can be found in body structure as well as in the socio-economic status between the ethnic groups living together in a society[42,43]. To avoid these difficulties as much as possible, the socio-economic status (SES) was estimated by using an index composed from the commonly used determinants of the families' socio-economic background in the European populations. Children were divided into socio-economic status subgroups by considering the education and occupation level of the parents and the number of children in the family:

$$\text{SES index} = Ed_{father} + Ed_{mother} + Occ_{father} + \\ + Occ_{mother} + 2\times Ch$$

where Ed_{father} and Ed_{mother}: parental education (1 – unfinished elementary school; 2 – finished elementary school; 3 – vocational training school; 4 – secondary school; 5 – higher education); Occ_{father} and Occ_{mother}: parental occupation (1 – unemployed; 2 – retired, homemaker; 3 – blue-collar worker; 4 – white-collar worker; 5 – white-collar worker with higher educational level); Ch: number of brothers and sisters of the studied child in the family (the studied child has: 1 – 4 or more brothers/sisters; 2 – 3 brothers/sisters; 3 – 2 brothers/sisters; 4 – 1 brother/sister; 5 – no brother/sister).

The 75th (cut-off score: 24) and 25th centile (cut-off score: 19) values of the index were used as cut-off limits to divide children into relatively good (SES1), average (SES2) and relatively poor (SES3) socio-economic subgroups.

Results only on the comparisons of children's growth pattern living in relatively good and bad socio-economic background (SES1/SES3) were selected for this presentation.

Factor analysis was used to construct the SES index[44]. The selection of household wealth related variables (e.g. living standards as TV or car ownership; housing characteristics: sanitation, number of rooms in the house; demographic variables: number of family members or number of children in the family, socio-economic proxis: parental education and occupation, etc.) was based on the analysis of SES variables' differentiation in the Hungarian population and the analysis of the relationship among the variables. The final choice of asset variables (parental education and occupation, number of children in the family) was in coincidence with many other epidemiological auxological surveys' results, since parental education and occupation as well as the number of the family members have been found to have the strongest effect on growth among the determinants of socio-economic status[7,45–48].

Hypotheses were tested at 5% level of random error by using SPSS v. 18.0: by using Student's t-test in variables having normal distribution and by Mann-Whitney test in the non-normally distributed variables. Normality of the age-group's distribution was tested with the Kolmogorov-Smirnov test. χ^2-test was used for testing the homogeneity of distributions.

Results

Body development vs. socio-economic status

Stature

It could be stated that children and adolescents living in relatively good socio-economic familiar background (SES1) were taller (generally with 2–3 cm) than their age-peers living in relatively bad socio-economic background in both genders (Figure 1).

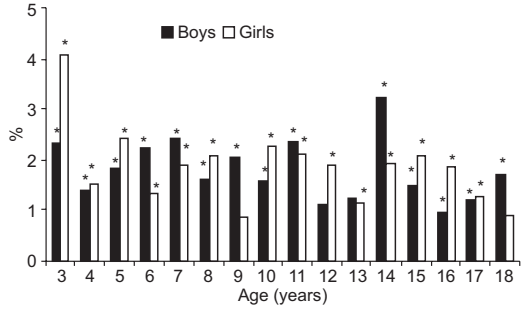

*Fig. 1. Differences between the SES subgroups' mean body height (%) in children and adolescents (SES1-SES3, expressed in the percentage of SES1; SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, Student's t-test).*

Body mass

The body mass (Figure 2) of children and adolescents did not differ by the socio-economic development of the

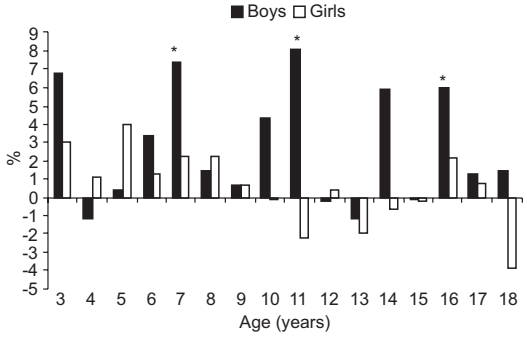

*Fig. 2. Differences between the SES subgroups' body mass medians (%) in children and adolescents (SES1-SES3, expressed in the percentage of SES1; SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, Mann-Whitney test).*

micro-environment (with the exception of some age-groups in the boys).

Body mass index

The body mass index of children with relatively good and bad socio-economic status did not differ in either of the genders through the whole studied age interval with the exception of 5- and 16-year old boys and pubertal girls (in these age-groups: children and adolescents living in relatively bad socio-economic conditions had significantly bigger BMI than their age-peers with better socio-economic background; Figure 3).

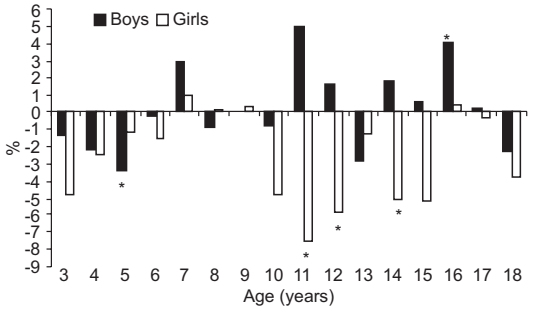

*Fig. 3. Differences between the SES subgroups' body mass index medians (%) in children and adolescents (SES1-SES3, expressed in the percentage of SES1; SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, Mann–Whitney test).*

Nutritional status vs. socio-economic status

BMI

The prevalence of underweight children decreased by age through childhood and stabilized around the age of 10 years in both genders and both SES subgroups (Figures 4 and 5). The prevalence of underweightness was significantly higher in the SES3 subgroups through the whole studied age interval in the boys (Figure 4), while only in childhood (till 9 years of age) in the girls (Figure 5). The frequency of underweight adolescent girls was similar in the SES subgroups.

The distribution pattern of overweight and obese children was very similar across the social strata both in the boys and the girls: the joint prevalence of overweight and obese children increased by age till puberty in both genders, then decreased till the end of the studied age interval in the girls, while after a slight decrease in puberty increased again in postpubertal boys (Figures 6 and 7). By considering the differences in the prevalence of overweightness and obesity across the SES subgroups, the joint prevalence of overweight and obese children was higher (with 3–7%) in the relatively poor socio-economic subgroup than in the SES1 subgroup with better socio-economic background (with the exception of some age-groups; Figures 6 and 7).

Subcutaneous fatness

Although the differences were significant between the SES subgroups' subcutaneous skinfold thicknesses only in the age-groups 4, 11 and 18 years, as a general ten-

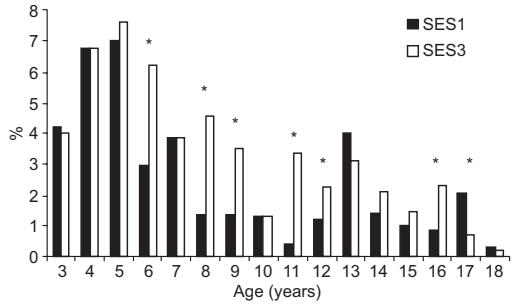

*Fig. 4. The prevalence of underweight boys by the socio-economic status (SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, χ^2-test).*

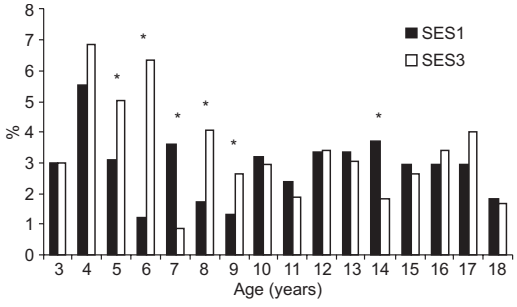

*Fig. 5. The prevalence of underweight girls by the socio-economic status (SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, χ^2-test).*

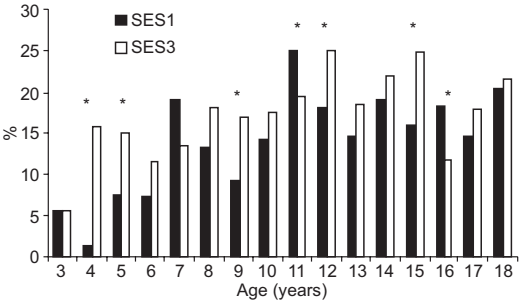

*Fig. 6. The prevalence of overweight and obese boys by the socio-economic status (SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, χ^2-test).*

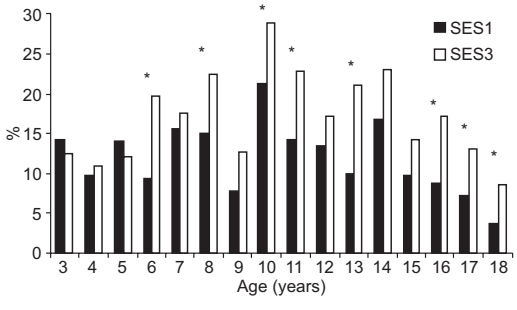

*Fig. 7. The prevalence of overweight and obese girls by the socio-economic status (SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, χ^2-test).*

dency, it was observed that the subcutaneous fat accumulation of girls living in better socio-economic background was significantly smaller than in SES3 girls. The same tendency was found in the boys, but only in childhood (between 3–5 years) (Figure 8).

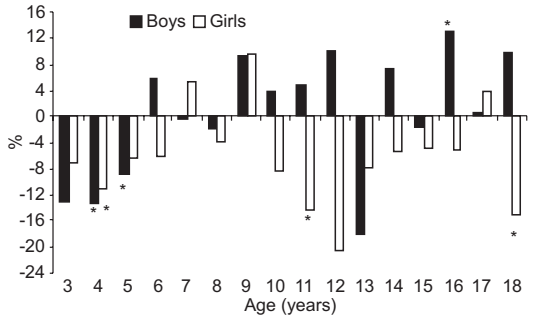

*Fig. 8. Differences between the SES subgroups' sum of subcutaneous skinfold thicknesses (median, %) in children and adolescents (SES1-SES3, expressed in the percentage of SES1; SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, Mann-Whitney test).*

Skeleto-muscular development

By regarding the mean upper arm muscle area of the SES subgroups, there was not any difference between the socio-economic subgroups in this anthropometric indicator of skeleto-muscular development in either of the genders (Figure 9).

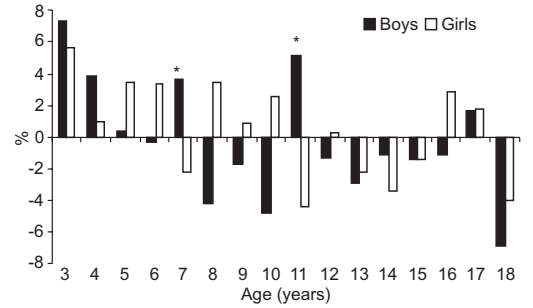

*Fig. 9. Differences between the SES subgroups' upper arm muscle area medians (%) in children and adolescents (SES1-SES3, expressed in the percentage of SES1; SES1: relatively good socio-economic background, SES3: relatively poor socio-economic background; *: significant difference, Mann-Whitney test).*

Body shape vs. socio-economic status

Body shape of boys did not differ by the socio-economic status of the families; not only the category of the SES subgroups' mean somatotypes was the same in every age-group, but the mean somatotype components of the SES subgroups were similar as well (Figure 10).

Contrary to the boys, after the age of 10 girls' body shape showed differences between the SES subgroups, i.e. the somatotype of girls living in worse socio-economic conditions was more endomorphic than their age-peers living in better socio-economic background (Figure 11).

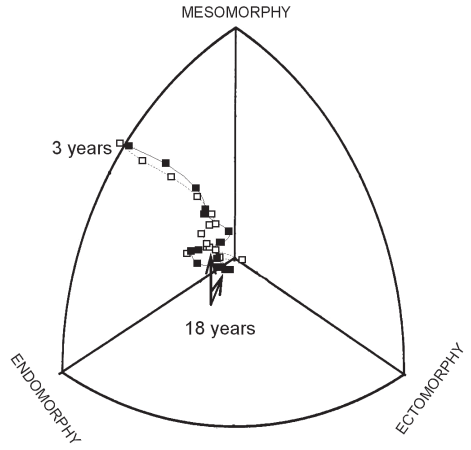

Fig. 10. Mean somatotype of boys by the socio-economic status (■: relatively good socio-economic background, □: relatively poor socio-economic background).

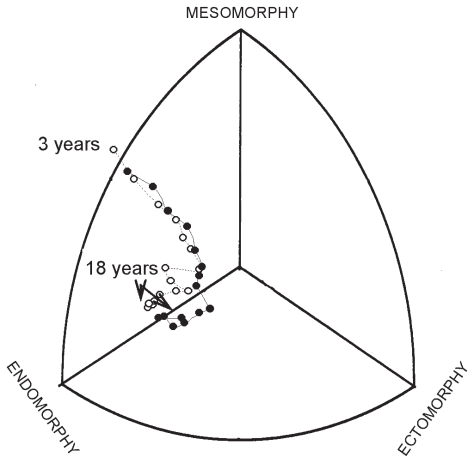

Fig. 11. Mean somatotype of girls by the socio-economic status (●: relatively good socio-economic background, ○: relatively poor socio-economic background).

Discussion

The growth pattern of Hungarian children and adolescents living in different socio-economic environments differed significantly in the turn of the 3rd Millennium at the micro-environmental level (estimated by the socio-economic status of the families). By comparing some absolute body dimensions, BMI, nutritional status and body shape indexes it could be stated that:

(1) Children and adolescents living in better socio-economic conditions were taller and had similar body mass than their age-peers growing up in worse socio-economic conditions in both genders.

(2) These differences of stature and body mass imply and explain the differences of nutritional status between the SES subgroups, namely, the children and adolescents living in relatively good socio-economic background had a better chance to develop normal nutritional status than their age-peers growing up in relatively poor background

in both genders. Both forms of not normal nutritional status – underweight and overweight/obese status – were higher in children living in worse socio-economic conditions (with the exception of underweight pubertal girls, there was not any SES difference in this age-group of girls: presumably due to the more and more active weight--control behaviour of pubertal girls independently of the socio-economic status). The paradox – obese and poor – can be explained by the relationship between the socio--economic status and dietary as well as physical activity behaviour[17,49–57].

(3) Although the linear dimension, the stature and the three dimensional measurement of body extent, the body mass, showed different tendencies in the SES subgroups' comparison, the relative mass (BMI) of the SES subgroups did not differ significantly, with the exception of pubertal girls (better socio-economic conditions predestined smaller BMI). By considering the results of the nutritional status and body shape analyses we can conclude that pubertal girls' smaller subcutaneous fat accumulation in the subgroup with relatively good socio-economic background led to these SES differences in the body structure in puberty.

Conclusions

In accordance with the observations of many other European epidemiological auxological surveys of the last decades[10,11,17,57–63] – the body structure of Hungarian children and adolescents differed across the socio-economic backgrounds in the beginning of the 2000s, i.e. children and adolescents living in good socio-economic conditions had better body development and healthier nutritional status than their age-peers' with poor SES. Stature and nutritional status were found the most sensitive indicator of body development to the socio-economic status in both genders.

The SES-related differences in the growth pattern of children and adolescents imply that the social support network should be developed to prevent these inequalities in the physical development of children and adolescents among the socio-economic strata in our society.

It is evidenced by numerous studies that the socio--economic level of the families can influence children's body development and nutritional status indirectly, through nutritional and habitual physical activity pattern and health behaviour[64–67]. All of these lifestyle factors form very early in life by unconsciously imitating the familiar habits. The healthcare professionals, schools and local policies could also play significant role in this learning process – since children can be taught to follow »healthy« habits till the age of 14–15 years – by providing age-specific dietary, physical activity and health behavioural recommendations to children and adolescents[68].

Until the social support network could eliminate these inequalities: our differences also emphasize the importance of using reference growth values layered also to socio-economic strata for screening retarded growth and development in childhood and adolescence

Acknowledgements and Declaration of Interest

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ODNOS IZMEĐU TJELESNE STRUKTURE I SOCIO-EKONOMSKOG STATUSA KOD MAĐARSKE DJECE I ADOLESCENATA

S A Ž E T A K

Među brojnim faktorima koji utječu na uzorak dječjeg rasta i razvoja, nalazimo čimbenike unutar promjenjive socio-ekonomske okoline. Nejednakosti među socioekonomskim slojem u Mađarskom društvu su porasle tijekom desetljeća. Glavni cilj istraživanja bio je ispitati tjelesnu strukturu djece i adolescenata koji žive u različitim socioekonomskim uvjetima. Ispitanici u ovom radu (9479 dječaka, 9304 djevojka) ispitani su unutar 2. Mađarske nacionalne studije rasta, 2003–2006. Tjelesna struktura je procjenjena prema apsolutnim tjelesnim vrijednostima, BMI, kompozicijom tijela i indeksom oblika tijela. Djeca su grupirana unutar relativno dobrih, prosječnih i loših socioekonomskim podskupina s obzirom na obrazovanje i zanimanje roditelja, kao i prema broju djece u obitelji. Značajne razlike pronađene su u tjelesnoj strukturi djece s obzirom na socioekonomsku pozadinu: bolji socioekonomski uvjeti su utjecali na više držanje kod oba spola, dok je niska relativna debljina pronađena samo kod djevojka u pubertetu. Prevalencija nezdravih prehrambenih statusa (kod pothranjenih kao i kod pretilih) su značajno manji kod djece koje žive u boljim socioekonomskim ujvetima kod oba spola. Razlike pronađene u tjelesnoj strukturi djece koja žive u različitim socioekonomskim uvjetima naglašavaju važnost korištenja referentnih čimbenika rasta prema socioekonomskom sloju za prikaz nutricionističkog statusa u djetinjstvu i adolescenciji.