

**Generation differences of physique and body composition in 7 to 18-year-old boys and their issues on the estimation of morphological age and prediction of young adult height**

Ph.D. thesis

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## **Introduction**

Results of human biological studies have proved that differences between the physique characteristics of the successive generations are remarkable. By the train of thought of the authors we can conclude that environmental conditions that induce healthy child development have become more and more favourable. The speed of secular growth changes can be assessed by the measured data, however, the accuracy of these predictions can be modified by several unknown factors. By the orthogonal polynomial predictions of Mészáros and Mohácsi (1983) the calculated and interpolated standards of their growth study could be valid only in 15-20 years. The authors stressed also their prediction can be true if the environment will not change during the mentioned period. The increase of life standard between 1983 and 2008 is out of question, but this socio-economic development resulted in negative consequences too. These negative trends may significantly decrease or equalise the positive consequences of secular trend.

The changes in lifestyle of school-age population were analysed in two recent publications. By the observations of Laki and Nyerges (2000) and also the co-workers of Central Office of Statistics (2000) the level of habitual physical activity of 7 to 18-year-old boys have been decreased significantly during the past 15-20 years. The recent anthropometric investigations prove the energy intake rather increased than decreased. The joint effect of the mentioned two factors naturally is the significant increase in body fat content with all of their collateral consequences that will manifest after decade or decades. Alarming statistics can be read in the work of Kopp and

associates (2004). Namely: the prevalence of chronic pediatric diseases has been increased significantly during the past two decades. The authors found a significant parallelism between the increase in prevalence of overweight and obesity and chronic diseases. There is no difference between the rates of increase and also the relationship between the two mentioned facts cannot be excluded. The question arises necessarily: whether or not the negative consequences of the modified lifestyle may equalise the positive consequences of the secular growth trend?

### **The aim of the study**

By human biological and statistical comparisons of the results of nation-wide representative growth studies finished in 1983 and 2005 the first aim of this study was to determine the quantitative and speed characteristics of secular growth changes.

If the sample differences were significant, our second aim was to create the new calculated and interpolated standards for the estimation of morphological age and prediction of final stature.

The following questions were done:

1. Were the size and physique character differences arising from the secular growth trend of similar scales and directions during the 22 years of the observation period?
2. Did develop significant inter-sample differences between the physique characteristics if the constitution was described by the metric and plastic indices?
3. Were there difference between the prevalence of only overweight and really obese children, adolescents

and post-adolescents between the two nation-wide representative samples?

4. Are the morphological ages and predicted final statures different if we calculate them by the two observed standards?

### **Material and methods**

The comparative data collection was carried out between 2002 and 2005. A total of 13,338 boys aged between 7-18 years took part in the investigation. The sample represents the school-age population by 1.5%. To ensure the comparability of the samples the guidelines used in the 1983 investigation were followed. These are:

- the recorded number of boys in the elementary and secondary schools, and the scheduled number for the next year,
- the number of inhabitants and geographic location,
- the pattern of employment in the settlements,
- the type of the schools.

For the qualification of somatic development, nutritional status and physique 12 body dimensions were taken follow the suggestions of IBP (Weiner and Lourie, 1969). The growth type was described by the Conrad (1963) technique. Body composition was estimated by the relative fat content (Parízková, 1969) and body mass index (BMI). The BMI cut-offs were determined by the suggestions of Cole and associates (2000). Sample differences of the prevalence of overweight and obese boys were analysed by *chi*<sup>2</sup>-tests. Differences between the means of morphological age and final stature calculated by the two different references were analysed by *t*-tests for dependent samples.

## **Results**

The mean heights were consistently and significantly taller in the 2005 investigation. The trend-lines described by the means run parallel. By the results of Bartlett and Levene tests the respective standard deviations did not differ. Differences of the order of centimetre between the height means are the positive consequences of secular trend.

Differences between the weight means were also significant. The boys of 2005 study were consistently heavier. The trend lines are divergent the successive differences increased with age. The standard deviations were large in both samples, but there were no significant between-sample differences. The weight differences can also be related to the secular trend, but their positive or negative qualification can be made by the knowledge of nutritional status differences.

The age related patterns described by the relative fat content means were similar in both samples, but the second power curves run parallel. The body fat content means were greater in the 2005 study. The only exception was the group of 12-year-old boys where the means are: 18.5% and 19.5% respectively. The significantly greater relative fat content and the greater BMI means from 11 years of age indicate that the body mass in the 2005 sample was not proportionate with the taller stature. Consequently the heavier body mass cannot be evaluated as the positive consequence of secular trend.

Prevalence of overweight and obese boys supports also our opinion. The relative frequencies were consistently greater in the 2005 sample. It is thought-provoking that prevalence characterises the 9-year-old boys now-

days was observed only in the 18-year-old group in 1983. The between-sample differences were marked from puberty to 18 year. Every 4-5 boys were nowadays definitely overweight or obese.

If the morphological age of the boys of 2005 study was calculated by the 1983 references almost all the boys were qualified as being older than their real biological development, but there were no significant differences between the standard deviations.

The differences between the calculated two morphological ages influenced the prediction of young adult stature. The correlation between the two predicted heights was close the coefficients explain 94% of the common variances in spite the fact that the prevalence of probably short and tall subjects were remarkable in every age group. Predictions made by using the 1983 standards resulted in slightly taller final stature only in 9 boys. The mean difference between the two estimations is greater than 2.5cm. Consequently the standards for the calculation of morphological age and prediction of young adult stature are not valid at the beginning of the new millennium. The marked differences that influence the validity of these standards can be explained by the changes of lifestyle and life standards. Opposite to the estimations of Mészáros and Mohácsi (1983) their validity has been come to an end at the end of past century. Calculation of the new developmental curves was reasoned both in practical and theoretical approaches.

The consequences of 22 year period secular growth trend were analysed in this thesis. For the comparison we used the results of two nation-wide representative anthropometric studies. Above all environmental factors that

could be supposed behind the significant size, body built and body composition differences were also highlighted.

### **We have found**

1. Size, physique and body composition differences that can be related to the yet continuously existing secular growth trend do not mean the same human biological contents. Generation differences between the successive height means can only be evaluated as positive. The differences in body weights were not proportionate with the significantly taller height means. This result is obviously environmental effect it is one of the consequences of definitely hypoactive lifestyle. The significantly heavier body mass is the function of the significantly greater relative body fat content.

2. The linearity of physique of the school-age population increased significantly during the 22 year observation period. That is the chest diameters relative to stature have been decreased. Did not change the bone-muscle development of the boys was characterised by the plastic index. These were numerically smaller in some age groups.

3. The more leptomorphic (more linear) physique and the greater relative body fat content are contradictory attributes human biologically. Our consistent observations cannot be evaluated as sampling error. The increase in body linearity and also the stagnation (sometimes the decrease) in bone-muscle development are the negative consequences of secular growth trend.

4. The prevalence of overweight and obese boys (if these states are characterised by the relative body fat and BMI) increased significantly during the 22 year observa-

tion period. The joint prevalence of these two risky conditions ranged between 23% and 27%. These proportions are higher than those in the surrounding countries of in Western-Europe. The prevalence of definitely obese boys increased more fast during the past two decades. This result is more than warning. It is rather dangerous, since it endangers the health status of the growing generation, whether we like it or not within a short period of time. It is not an astonishing result (it is rather sad) the increase of chronic pediatric diseases in Hungary was proportionate with the increase of over-nutrition rate. It is not probable that the peak of the mentioned almost parallel trends has been reached its maximum level following the turn of the new millennium.

The significantly greater body mass means, including smaller muscle mass and greater depot fat are also the negative consequences of secular trend. These attributes have developed in the function of unfavourable environmental effects. It cannot be reassuring that the similar quality of generation differences are not the attributes of Hungarian children and adolescents exclusively. Beyond the hypoactivity, in the background of very unfavourable body composition other socio-economic effects can also be supposed. To stop or modify the observed unfavourable trends cannot be the tasks of families and schools exclusively. A general social interference is required.

5. The observed significantly taller height means (come from the secular growth trend), the heavier body mass (arise from the environmental effects), and the unchanged plastic index means have been modified remarkably the results of the method (published in 1983) for the assessment of morphological age and prediction of young



adult stature. The morphological age calculated by the 1983 references was consistently older in the random samples of 9-13-year-old boys investigated in 2005. As one of the logical human biological consequences the means of predicted young adult height were also significantly different. Our results suggest that the fat correction of estimator variables would also be important for the more accurate estimations.

6. The results of a specially structured human biological investigation were introduced and evaluate in this thesis. Nevertheless, it is our conviction the analysed subjects does not belong simply or exclusively to competence of the anthropometry. That is, neither the families nor the children can make themselves independent from the economic status and life standard of closer or wider environment. It out of question, that the lifestyle and dietary habits mediated continuously by the adult generations have also important role in this respect.

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