Relationship between motor performance and anthropometrical characteristics of non-athletic children aged 7-10

Ph.D. Thesis

Ildikó Vajda

Semmelweis University
Doctoral School of Sport Science

Adviser: Prof. János Mészáros Ph.D.
Opponents: Dr. Kornél Sipos CSc.
Dr. Júlia Pápai Ph.D.

Head of Final Examination Committe: Dr. Kornél Sipos CSc.
Members of Final Examination Committee:
Dr. Pucsok József DSc.
Dr. Barabás Anikó CSc.
Dr. Szabó Tamás CSc.

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Introduction

The study of growth, development, maturation and the related changes in motor performance are equally central issues in sport science, in physical education at school and outside school, in human biology and in physical anthropology. As the study of healthy development goes back to over 150 years, it is beyond debate today that adult biological variability is also closely linked with external environmental factors in the first two decades of postnatal life.

In the past few decades there has been a continuous and sometimes senselessly sharp debate about the comparative value of longitudinal and cross-sectional methods in the examination of changes or relevance. It should be accepted as natural that the two approaches are not competitive but complementary. Yet for some scientists opposition is more attractive than efforts of cooperation. Several features of our quickly changing society can be seen as sources of intense risk factors, though they may take effect only later. The speed of changes in society is so high today that even during a longitudinal study covering the complete period of growth and development, the number of active components and their value may change significantly. It seems this fact would justify a description based on cross-sectional surveying, as it needs a shorter time period. The description of the speed of age-related changes, however, requires longitudinal examination exclusively, yet constancy of the active components is not granted even in the time span of a few years.

The purpose of the analysis involving preadolescent girls and boys (in the first four years of primary school) is to give a description of their body development, the

age-related change as well as pattern of their body composition and motor performance.

Questions to be answered:

- Are there any differences between pre-adolescent girls and boys in respect of the changes of their body dimensions and physique characteristics during the 3.5 years of observation period?
- Is there any gender-related difference in respect of absolute value and age relation in nutritional state figures?
- Is there any gender-related difference in respect of physical performance described by motor performance test results and in respect of the speed of changes in performance?
- Are there gender differences between the statistical relationships of somatic and performance characteristics?

Subjects and methods

Nyíregyháza has 22 primary schools. The survey of anthropometric and motor performance was carried out in 11 schools of the town, on two yearly occasions between 2003 and 2006, which provided altogether seven survey results. Two of the 11 schools are maintained by churches. According to data supplied by the local educational authorities, in the 2002/2003 academic year the number of children starting school was 1414. The complete survey comprises the kinanthropometric traits of 196 girls and 205 boys, which is more than 28% of all the children belonging to this age group in the town.

In order to describe changes in somatic development and body composition, we analysed age-related changes and gender-related differences in respect of body height,

body mass, body fat content estimated by Parízková's method, as well as the linearity and bone-muscle development indices. Motor performance was described by the results in 30m dash, standing long jump, fist ball throw, 400m run and the distance completed during the Cooper-test.

Results

Differences in body height means at different survey times show consistent and significance in both groups ($F_{girls} = 9200$ and $F_{boys} = 6538$), but there were no significant difference between the respective means of girls and boys, i.e. the small numeric differences between the means were statistically insignificant. The standard deviations or the variabilities expressed in percentage of the means are numerically greater in boys but do not show any statistical difference. It is important to underline that the standard deviations were also independent from the means. The moderately greater body height of girls, an effect of their earlier maturation, could only be recorded at the 6^{th} and 7^{th}data collections. Linear correlation coefficients indicating calendar age relevance of body height ($r_{girls} = 0.70$ and $r_{boys} = 0.66$) were significant, but in light of statistical data the common variances of calendar age and body height were only moderate. They are 49% in the sample of girls and only 44% in that of the boys. The calculated rises are statistically identical, therefore in reality the two lines are in fact the same, so they coincide.

The age-related growth in body mass is also consistently significant in both genders ($F_{girls} = 386.4$ and $F_{boys} = 762.5$), but between the mean values of body mass of girls and boys there was no statistical difference at any of

the surveying times. The numeric values of standard deviations were slightly greater in boys in this case as well. However, according to the Levene-test this difference is not significant either. The calendar age related increase in body mass was also significant in both groups and due to the age domain it was also linear. On the basis of Z-transformation results the correlation coefficients indicating the link between the two features previously mentioned are statistically the same. The numeric difference between determination coefficients was also moderate. However, the noteworthy result is that the age-related change in body mass shows greater variability than the growth in body height.

According to the original algorithm the change of the growth type of girls is leptomorph-picnomorph. The linearity scores calculated by the boys' algorithm is definitely metromorph-leptomorph, although due to the survey arrangements the children were the same.

The growth pattern and gender-related means of body fat expressed in percentage of body mass are significantly different from the basic data or the trends of change seen in the index calculated from basic data. The growth of relative body fat content is significant in both groups ($F_{girls} = 328.1$ and $F_{boys} = 346.8$), but after the initial fast fat accumulation the increase in depot fat was slightly slower. At the first four times of observation the relative body fat content of girls was significantly higher than that of boys, at the last three times, however, the means were statistically the same in both groups. The standards deviations around the means were great in both groups, exceeding 35% of the respective means. The increase in body fat was significant in both groups, but the

common variances were low, 9%. In this comparison the fat gain of boys during a period of 3.5 years was significantly faster than that of girls.

Improvement of running speed was significant in both groups ($F_{girls} = 318.4$ and $F_{boys} = 266.1$), change during 6-months periods was consistently significant, and no seasonal fluctuation of means is discernible. The development of speed is more definite in both groups at the beginning of the whole survey period. The standard deviations were not higher in comparison with other national analyses. It is statistically important that the variability indices do not change in accordance with the almost linear decrease of means. In this study the running performance of boys was consistently better than that of girls. The age-related decrease of gender-related difference in performance is only slight.

The short distance running endurance of our survey subjects was described by the scores in 400m run test. Running time decreased significantly in both groups in accordance with age ($F_{girls} = 134.6$ and $F_{boys} = 163.2$), but the performance increase during the 6-month period was not significant statistically. The children's performance, even in comparison with non-athletic ones, is rather heterogeneous, relative standard deviations are great, between 13-18% of the respective means. Curiously enough, numerically greater standard deviations were found in the sample of boys. The performance of boys is better at all the observation times in this test as well.

Age-related increase and gender-related differences in cardio-respiratory and metabolic endurance were described by distances completed in the Cooper-test. The F tests of the ANOVA were significant in both groups

(F_{girls} 51.33 and F_{boys} = 49.25). In light of the critical differences performance change was the slowest in this test. It is general the 12-month period increase of performance that shows any significance. In the successive means of boys there was a relatively long period of stagnation (data collections 4-6), when significant increase in distance was only achieved in a period of 18-month spontaneous development. The distances run individually are significantly different in both groups, and the standard deviations were consistently great, but no relevance of variability indices to means and no gender-relation of their differences can be proved. Cardio-respiratory endurance was assessed as very moderate in both groups. At the first three data collections no statistical difference could be found between the performances of boys and girls. At the next four data collections, however, boys ran significantly longer distances in 12-minutes.

The greatest differrence between the two groups was recorded at the forth data collection, and this difference is only 173m.

The correlation analysis of anthropometric traits and physical performance showed consistently similar results in both genders.

The age-relation of motor performances was stronger than the relation with body sizes and traits. Motor test results are not independent of body sizes, physique characteristics and body composition, but the common variances calculable on the basis of significant correlation coefficients were very small.

The patterns of significant correlations are gender-related. Body height is consistent and its effect on BMI test results. Based on the patterns of correlation coefficients,

the role of body mass was similar, but the patterns of gender-related relationships were slightly different.

It is to be underlined that the effect of plastic index on the increase of motor performance was only moderate in both groups, and the high depot fat effect only a moderate decrease in physical performances, primarily in endurance tests, i.e. in 400m run and in the Cooper-test.

Correlations between metric index and motor performance scores were of similar intensity as those presented by the plastic index, but for example the correlation of MIX with 400m run time were statistically closer in both genders than that of the plastic index.

Conclusions

- If the somatic development of children is only described by body height and body mass, the developmental patterns show little or no gender relevance, but the statistically identical body dimension means and standard deviations do not correspond to identical levels of biological development. The body height and body mass of children surveyed are significantly greater than those of children of the same age group were a few decades ago. The difference is caused basically by the generation change still effective in Hungary. The regional differences that could be rated 20 years ago seem to disappear.
- The morphological constitution of girls during the whole observation period of the survey is more leptomorphic than that of boys, even if the same algorithm of calculation is applied in both groups. This is probably an effect of sexual dimorphism. The physique of our survey subjects was more linear than that of girls and boys of the same age studied before. This increased leptomorphy

seems to be one of the measurable effects of a typical hypoactive lifestyle.

- Not depending on whether nutritional state is described by the body mass index or the body fat content expressed in percentage value of body mass, our subjects were overfed already at the first data collection. Increase in body fat content with age was significant even within six-month periods. The sample includes a great number of apparently overweight and obese children. The ratio of these numbers exceeds those typical in reference groups and can be interpreted as serious health risks. Increased fat deposit is an unequivocal effect of lifestyle. Acceleration in body fat accumulation also showed gender relevance. During the survey period the initially low deposited fat of boys accumulated significantly faster. By the 7^{th} data collection the gender-related difference is no longer significant.
- Assessed with motor performance test results the physical performance of children is weak. The most serious backwardness compared to the reference data was recorded at tests requiring co-ordination and cardio-respiratory endurance. The very moderate physical performances are, however, only partially accounted for by the presence of significantly greater depot fat. More important is a lifestyle lacking in exercise, and for this problem the present system of physical education and the number of P.E. lessons at school cannot provide a solution. The age-dependency of performances at each test was significant, but the developmental speeds were consistently moderate. Where the linear regressions constants showed gender relevance, changes in the boys' performance were faster. The development speeds in the sample are signifi-

cantly lower than those in the findings of previous surveys. This difference is again an effect of lifestyle.
- Mutual correlations of motor performance tests were significant in all pairings in the two groups, but this statistical connection is consistently loose. The interpretation of the result can be that the performance profile of children surveyed is very uneven already at the level of the presented moderate performance. As the tests applied were natural activities, the conclusion can be made that these are not included in children's leisure activities with sufficient duration and frequency. With the subjects of the survey spontaneous development of basic level fitness (i.e. not only fitness necessary for describing physical performance) and co-ordination fell short of the level typical of the age group. In light of the results, the degree of effectiveness necessary for eliminating this gap cannot even be guessed. The interests of the next generation, however, would require substantial changes both in physical education at school and in children's lifestyle.

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