ORIGINAL ARTICLE

Morphological characteristics and motor abilities of boys aged 15 and 17

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Abstract

Measuring of morphological characteristics and motor abilities was performed on the sample of 51 male students of the secondary traffic school "Pinki" from Novi Sad. Body height and body mass were used for measuring of morphological characteristics, and results of standing long jump and running at 30 meters with standing start were used for measuring of motor abilities. The body mass index was calculated after the results were obtained. The aims of the study were to establish and analyze differences in the results of morphological status and explosive strength of students measured in different periods, in the first measurement when the subjects were 15 years old and in the second measurement when the subjects were 17 years old. The data obtained in the study were analyzed using repeated measures ANOVA. The obtained results indicate the existence of statistically significant differences between first and second measurement in all morphological characteristics and motor abilities, at the level of significance of $p<0.05$.A significant increase in morphological characteristics and motor abilities with age, indicating that boys have adequate growth and development for their age.The age factor has a significantly stronger influence than the factor of the curriculum for the physical education in this high school.

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Keywords adolescents · anthropometric parameters · standing long jump · running at 30 meters

Introduction

Growth and development of young people in the period between 15 and 17 is heterochronic and non-linear. This discrepancy between growth and development is reflected by the difference in motor conduct and change of anthropometric measures among sexes, through non-linearity disparity of growth and development of certain anthropometric properties with an individual, and compared with that individual's peers. Young people in this age are more influenced by all the factors of contemporary living than the adult population. Hypokinesia, obesity, environmental pollution, unhealthy living conditions, "fast food", decreasing number of sports fields and green areas in populated places – are just some of negative factors disturbing the regular growth, development and health of young people. Reduction of the negative effects may be conducted through physical activity with a beneficial impact upon health, as scientifically proven. The obvious decrease of attitudes of students in this age to physical education in all the segments (motor abilities, motivation factor, etc.), increased impact of disturbing factors on the lives of students even in such a short-term period, abrupt, and in some cases, unadjusted body mass and height gain on one hand, and explosive strength – as an indicator of general strength, on the other hand, are the facts that made the authors interested in this kind of study.

Model of the structure of morphologic characteristics consists of four morphological factors: longitudinal dimensionality of the skeleton, transversal dimensionality of the skeleton, body volume and body mass, and subcutaneous adipose tissue (Kurelic et al., 1975; Momirovic, 1969). Monitoring of morphological characteristics in the field of kinesiology research is also done by the use of body mass index (BMI) as the control indicator of physical constitution. Increased levels of BMI are believed to reduce the levels of motor abilities of children of different ages (Graf et al., 2004).

According to data for 2006, more than two thirds of adult population in Serbia is physically inactive (67.7%). The percentage of adult population that exercised more than three times a week, to the extent that they lost breath or became sweaty, was 25.5% that is significantly higher than in 2000, when that percentage was 13.7% (National Health Survey Serbia). The survey (Zotovic & Petrovic, 2010) conducted on the territory of Vojvodina on the sample of 1103 students of secondary schools has shown that, out of all the offered activities, sport occupied 35% of free time, as compared to listening to music (90%), spending time with friends (78.5%) and going out (74.5%). In terms of sports, the preferred activities in free time are different between sexes – young men expressed a greater interest as compared to girls.

At the beginning of the secondary school, the biological development is intensive, uneven and heterochronic. The mid-secondary school age is characterized by prominent growth, with the rate of up to 10 cm per year (Ugarkovic, 1996). Young people in this age are very skilled and they achieve good results in physical activities.

Insufficient development of certain traits (abstract thinking, focus of attention, self-control, self-criticism) may be one of the causes because of which the today's youth motivation during physical education classes is at the low level.

In the context of overall development of the individual, the processes of growth, differentiation and functional maturation of tissue do not always go along with the pace of change, which causes different structure of morphological dimensions. These processes are particularly intense in the period of development between 11 and 17 years of age, in which formed are not only major morphological characteristics and the physical proportions, but also the changes in the development and the activity of certain tissues and organs. This period is the period of adolescence and in males extends from 12 to 13 to 17 to 18 years (Kurelic et al., 1975). During biological maturation physical potential is constantly evolving and improving, determining different physical characteristics of each individual.

In the period of rapid physiological development occurring during puberty in the age between 15 and 17, all the motor abilities are developed along with a rapid development of morphological characteristics that could, but do not have to be adjusted with each other (or have an adjusted development). The aim of the study is to establish the relations between the results of measuring of morphological status and explosive strength of students, measured in various periods.

Method

The method of this paper is a longitudinal study with one experimental group. The experimental treatment represented an established curriculum of physical education for the students of first, second and third grades of secondary school during their regular growth and development.

The sample of subjects consisted of 51 students, non-athletes, of the secondary traffic school from Novi Sad. The enrolment criterion for students was to be healthy at the moment of both tests, that they were not relieved from the classes of physical education, that they were 15 ± 6 months on the date of testing in the first measuring and minimum 17 ± 6 months on the date of testing in the second measuring. The first, initial measuring was performed when students were in the first grade of secondary school (15 years of age), and the second, final measuring, when they were in the third grade of secondary school (17 years of age).

Anthropometric measures were used for this study:

Body height (BH) – was measured using the anthropometer developed by Martin, with a 1mm accuracy.

Body mass (BM) - was measured using a digital balance.

Body mass index (BMI) – was calculated using mathematical standard formula.

Motor tests were used to compare differences in motor abilities:

Standing Long Jump (SLJ) - the student stands behind a line marked on the ground with feet slightly

apart. A two-foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. Students attempt to jump as far as possible, landing on both feet without falling backwards.

Running at 30 meters (RUN30) - the test involves running a single maximum sprint over 30 meters, with the time recorded. Start from a stationary position, with one foot in front of the other. The front foot must be on or behind the starting line. The students should provide hints for maximizing speed and encouraged to continue running hard through the finish line.

Measuring was performed once a year during the first and the third years of secondary school, in September and October. The first measuring was performed during the first half of the first year of secondary school, when students were 15, and the second one during the first half of the third year of secondary school, when students were 17. All measurements were performed over the period of two weeks in September and October, during the physical education class. The students were volunteers, male, without chronic health issues, and examined by a physician. Measuring was performed in the gym (fitness room) and on the open sports field belonging to the school.

The first part analyzed central and dispersive parameters, measures of asymmetry and kurtosis measures compared to the monitored parameters. The processed parameters are: mean(M), standard deviation (SD), minimum and maximum values (MIN/MAX), coefficient of variation (CV) indicating, within groups, in which feature a group varies more or less, and which group varies more or less, considering the treated features, skewness measures (SK) as a parameter of symmetry, kurtosis measures (KU) indicated the elongation, or flatness i.e. whether the observed distribution statistically significantly differs from the normal distribution, p-value of the Kolmogorov-Smirnov test ($p<0.05$). The difference between first and second measurements was analyzed by repeated measures ANOVA.

Results

The minimum and maximum values of morphological characteristics and motor abilities in the first measuring (15 years of age), as well as in the second measuring (17 years of age) are shown in the Table 1 and indicated that the values are in the expected range. Values of the variation coefficient point to the homogeneity of features. Increased values of SK indicated that the distribution is negatively asymmetrical, meaning that the distribution curve is inclined towards higher values, at BM, BMI, RUN30 (for the age of 15); and at BH, BM, BMI, RUN30(for the age of 17). The reduced SK values indicated that the distribution is positively asymmetrical, meaning that the result distribution curve is inclined towards lower values, for BH, SLJ (for the age of 15); and for SLJ (for the age of 17). Higher KU values indicated that the curve is elongated for BMI (for the age of 15); and for BH, BMI (for the age of 17). Negative kurtosis values indicated that the curve is flattened, for BH, BM, SLJ, RUN30 (at the age of 15); and for BM, SLJ, RUN30 (at the age of 17).

Table 2. Central, dispersion parameters and measures of skewness and kurtosis at the first measurement (15 years of age) and at the second measurement (17 years of age)

Variables	Initial measurement				Final measurement			
	M	SD	MIN	MAX	M	SD	MIN	MAX
Body height (cm)	172.53	8.58	156.0	188.0	178.03	7.01	165.0	195.0
Body weight (kg)	64.89	12.91	39.0	94.0	71.60	13.88	49.7	101.0
Body mass index (kg/m²)	21.65	3.17	16.0	32.6	22.51	3.78	17.1	33.9
Standing long jump (cm)	204.02	17.41	160.0	238.0	216.47	22.91	159.0	265.0
30m running (s)	4.72	0.35	4.20	5.50	4.59	0.38	4.00	5.60

Table 1 (continued).

Variables	Initial measurement				Final measurement			
	CV	SK	KU	p	CV	SK	KU	p
Body height (cm)	4.97	-0.05	-0.88	0.983	3.93	0.48	0.12	0.344
Body weight (kg)	19.90	0.46	-0.19	0.558	19.38	0.33	-0.87	0.809
Body mass index (kg/m²)	14.63	1.00	1.40	0.374	16.80	0.84	0.49	0.758
Standing long jump (cm)	8.53	-0.47	-0.20	0.860	10.58	-0.28	-0.20	1.000
30m running (s)	7.45	0.74	-0.27	0.190	8.36	0.71	-0.29	0.280

Based on the data presented, it can be concluded that the results of students are homogenous, in both first and second measuring, in morphological characteristics and motor abilities, and that their results were within the range of regular distribution and that the students had approximately the same body height, body mass and are at the similar level or running, standing long jump and that they were at the similar level of explosive strength.

These data support the theory that there was a clearly defined limit between the measured values of morphological characteristics and motor abilities of students aged 15, and the same students aged 17, meaning that the subjects in the second measuring were statistically significantly higher and heavier and that they express higher explosive strength and speed that in the first measuring when the subjects were fifteen years old.

The results in Table 2 indicated that there were statistically significant differences in all variables between the two measurements at the significance level of $p < 0.05$. The greatest observed difference was in the field of BH (.000), BM (.000) and SLJ (.000), followed by the results of RUN30 (.001) and BMI (.007).

Table 2. The differences between variables of students at the first and second measurement - 15 and 17 years of age (repeated measures ANOVA)

Variables	Initial measurement	Final measurement			
	mean±SD	mean±SD	F	p	η^2
Body height (cm)	172.53±8.58	178.03±7.01	72.839	0.000	0.593
Body weight (kg)	64.89±12.91	71.60±13.88	47.939	0.000	0.489
Body mass index (kg/m²)	21.65±3.17	22.51±3.78	7.881	0.007	0.136
Standing long jump (cm)	204.02±17.41	216.47±22.91	37.654	0.000	0.430
30m running (s)	4.72±0.35	4.59±0.38	11.618	0.001	0.189

Characteristics of every sub-sample of measuring were mostly defined by the RUN30 as its contribution to characteristics was 71.79% followed by: BH (12.82%), SLJ (12.82%), BMI (2.56%) and BM (0.00%). Homogeneity of the first measuring (15 years of age) is 68.63%, and of the second measuring (17 years of age) is 62.75% (Table 3).

Table 3. Characteristics and homogeneity measurements of morphological characteristics and motor abilities of students between the ages of 15 and 17 years

Variable	Initial meas.	Final meas.	con %
Body height (cm)	<	>*	12.82
Body weight (kg)	<	>*	0.00
Body mass index (kg/m²)	<	>	2.56
Standing long jump (cm)	<	>*	12.82
30m running	>*	<	71.79
N/m	35/51	32/51	
hmg%	68.63	62.75	

Legend: hgm%-homogeneity measurement; N/m-the number of respondents with the characteristics of the group; con%-contribution of characteristics to the performance measurement; *-the existence of statistical significance of differences

Based on measuring of morphological characteristics and motor abilities of students aged 15 and 17, the following can be stated: in the first measuring (15 years of age), running contributed more to measuring characteristics, and body height, standing long jump, body mass index and body mass contributed less to measuring characteristics, whereas in the second measuring (17 years of age), running contributed to measuring characteristics less, and body height, standing long jump, body mass index and body mass contributed to measuring characteristics more.

Discussion

In most cases, the results of this study were as expected. Limitation of this study was the small number of students, because other teachers in this school were not willing to participate in this study. The results from the first and the second measurement, were processed by repeated measures ANOVA, indicated that the largest statistically significant difference was found in the body height (0.000), body mass (0.000) and standing long jump (0.000), a smaller one in the running at 30 meters (0.001) and the smallest one in the body mass index (0.007). In the second measuring they ran faster, on average for only 13 hundredths of a second. On average, the students were 5.5cm taller, 6.7kg heavier, and their standing long jump was 12.5cm longer in the second measuring.

The students in our study were heavier, taller, faster and jump better in the second measuring, meaning that they were more developed and skilled, observed through the explosive strength manifestation. The relation between body mass and body height expressed through the body mass index was mildly increased and indicated that the height did not follow the increase in body mass in case of students in our study. The differences were the result of maturation, not the curriculum for the physical education. Conditions of realization of physical education classes are limited in this school. The school has a hall for physical education with insufficient exercise equipment. One week students have physical education in the hall, and second week they have physical education in a modified school hall way into the fitness center. Kovac, Leskosek and Strel (2007) examined differences in morphological characteristics and motor abilities of 16, 17 and 18 years old students of different high schools, and came to the conclusion that the majority of the variables improves with age. Unlike our results, improvement in the morphological characteristics and motor abilities were attributed more to the curriculum for physical education, rather than age. Similar results in their study get Glavac et al. (2015), which examined the differences in morphological characteristics and motor abilities of students all four years of the Military High School. The first measurement was carried out at the beginning of the school year, and second measurement at the beginning of the next school year, in all ages they were found progressive improvement in the morphological characteristics and motor abilities.

In many countries, the level of physical activity of children and adolescents is not satisfactory (Hallal et al., 2012) with regards to the recommended weekly level of at least 30 minutes of moderate physical activity a day, five days a week (WHO, 2010; Haskell et al., 2007; Pate et al., 1995), or a vigorous physical activity of at least 20 minutes, three times a week (Haskell et al., 2007). All the school children should engage in at least 60 minutes of moderate to strenuous physical activity every day, according to the recommendations of The Centers for Disease Control and Prevention and the American Academy of Pediatrics (2006). With technology progress, motorized transport, watching TV and Internet expansion, it is becoming more and more difficult to find time and motivation for exercise and maintaining the level of the fitness required for healthy living. Recent studies indicate that about 60-70% of population in the developed countries does not achieve the minimum level of physical activity (Trost, Owen, Bauman, Sallis, & Brown, 2002). Krsmanovic, Simic, Batez, & Scepanovic (2015) found, among boys aged 17-18 years who are engaged in physical activity at a high level (> 300 minutes per week) or at a moderate level (150 to 300 minutes per week), a positive difference in the field of motor abilities, compared with boys who engaged in physical activity at a low level (<150 minutes per week) or they not involved in any physical activity. The results of the study of Moore et al. (2012) indicate that persons fulfilling the minimum required levels of physical activity (150 minutes of moderate intensity per week) can expect to live 3.5 years longer, whereas those willing to exercise regularly at a moderately high to very high intensity level, about 300 minutes per week, can expect extra 4.2 years of life. Physical activity has numerous positive effects: it strengthens the skeletal muscles, tendons and ligaments, increases bone density, and all of that influences the proper growth and development of

every individual's body (Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010). Exercising and sports are significant parts of childhood, and children who establish regular habits for physical activity will certainly continue with the physical activity in the adult age, too (Dahab & McCambridge, 2009).

Conclusion

In this tempestuous period of growth and development bodies of boys and girls are influenced by numerous factors of contemporary living. Apart from positive factors, there are many negative ones, such as hypokinesia, unhealthy "fast" food and lack of awareness of healthy life style.

The longitudinality in this survey provides certain guidelines for the development of the studied abilities and measures due to a short period between the two measurements. Overall increase of the level of health is reflected in the option to analyze the present status of students. The greatest significance of the study is reflected in the simplicity and accessibility of testing and measurement, and in the option to compare the present status of students with the previous measurements. Use of relatively simple tests and measures enables the study to be repeated in more schools and with more students, over a longer term, regardless of a generation of students and a geographic location of subjects.

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