INTRODUCTION

The physical capabilities are of great importance when it comes to the health of the child in his childhood and adolescence (Myers J, et. al. 2002; Andersen LB, et. al. 2006). Even among the children and adolescents, physical abilities are inversely associated with cardiovascular risk factors for chronic disease such as high blood pressure (Sallis JF, et. al. 1998; Ruiz JR, et. al. 2006), total fatness (Ruiz JR, et. al. 2006), hyperinsulinemia (Gutin B, et. al. 2004), abdominal adiposity (Brunet M, et. al. 2006), atherogenic lipid profile (Mesa, J.L, et. al. 2006) insulin resistance (Gulati M, et. al. 2003), and clustering of metabolic risk factors (Brage S., et. al. 2004; Ruiz J.R, et. al. 2007).

However, some tests have shown that the content, the amount of material, the intensity of instruction and the conditions in which the children take P.E. classes do not correspond to the needs of today’s students (Bokan, 1999; Jovanović, 2009; Nikolić, 2007). The development of new, modern physical education curriculum requires an appropriate analysis of the behavior education programs. When developing a curriculum it is important to be cognizant of the gender characteristics as a result of some researches that have shown significant differences in the morphological characteristics and motor skills between the boys and girls in the ages of 6 to 14 years old. Due to the accelerating and fast changes in eco-social sustain-
ability, the researches that observe the results in this type of area should be periodically repeated, since they become “out-of date” (Gajević, 2009).

The methods and working techniques used for this research are typical for transversally characterized works. The subject of this research is the study of the dynamics of the physical characteristics of children aged from 6 to 14 years old. The aim is to detect the differences in the dynamics of the development of the physical characteristics among children aged from 6 to 14 years old.

**WORKING METHODS**

The research was conducted on a sample of 4162 research participant, students from the primary schools in the municipality of Kisela Voda. The sample is divided into two sub-samples by gender, out of which 2103 male and 2059 female respondents. Each of the sub-samples is further divided according to the chronological age in 9 age groups in the span of one calendar year. The chronological age has been defined on the basis of decimal years (difference between the measurement date and date of birth, which are transformed into an appropriate sized division of the year into ten instead of twelve months). Accordingly, there are 9 male age groups and 9 female age groups established in span of one calendar year, as follows: 6 (6 - 6.9), 7 (7 - 7.9), 8 (8-8 9) 9 (9 - 9.9), 10 (10 - 10.9), 11 (11 - 11.9), 12 (12 - 12.9) 13 (13 - 13.9) and 14 (14 - 14.9) years.

The sample was composed of all students for whom their parents had given consent to participate in the project and were psychologically and physically healthy and regularly attend classes in physical and health education. Measuring has been realized in standard school conditions of regular classes at physical and health education.

Experts in the field of kinesiology who were previously trained to evaluate motor tests carried the evaluation out.

Prior to the beginning of this research, the researchers involved in the project undertook training sessions in order to guarantee the standardization, validation, and reliability of the measurements (Moreno LA, et al. 2003). Three tests, forming part of the EUROFIT battery, validated and standardized by the European Council, were applied in the following order: “Standing long jump test” (the maximum horizontal distance attained, with feet together, was measured. This test evaluates lower limb explosive-strength), Bent Arm Hang Test. (A standardized test was used to measure the maximum time hanging from a fixed bar. This test estimates the upper limb endurance-strength), sit-ups in 30 sec. (Maximum number of sit ups achieved in 30 seconds. This test measures the endurance of the abdominal muscles).

In all age groups for the three tests the following parameters were calculated: basic statistical parameters: the arithmetic mean (X), standard deviation (SD), variability coefficient (VC%), the minimum score (Min), maximum score (Max); Kolmogorov-Smirnov method for testing the normality of the distribution of results (KS); differences between age categories and sex in a test jump in distance from place determined by multivariate and univariate analysis of variance (MANOVA and ANOVA). To determine which sub-samples mutually differ statistically, in variable where there is a statistically significant difference the LSD - test was applied. Data was processed with the statistical package SPSS for Windows Version 15.0

**RESULTS AND DISCUSSION**

Graph 1 and tables 1 and 2 show the results of the motor skill test “standing long jump” that evaluates the lower limb explosive strength. The movement of the curve in graph 1 shows us that the explosive strength of the boys increases the older they become. The movement of the curve shows us that the explosive strength of the girls gets better until the age of 11 and after the age of 11 there is a mild decrease in the results from year to year. The average length of the jump of the motor skill test “standing long jump” is 10,00 cm among 13 and 14 year old children and 5.63 cm and every year it can increase from 4,21 to 13,21 cm for both genders.

The highest acceleration of the explosive strength among girls can be noted between the age of 11 to 12, when the female research participants improve their test results for 10,59 cm. The highest acceleration of the explosive strength among boys can be noted between the age of 13 to 14, when the male research participants improve their test results for 13,21 cm.

The motor skill test “Standing Long Jump” shows the highest variability at the age of 13 (boys) and at the age of 14 (girls).

The results prove us that there are statistically
significant differences between the boys and girls of all age categories, benefiting the male participants.

The analysis of the LSD-Test confirms the intensive and constant changes of the explosive strength in the lower limbs. There is a statistically significant difference in the results of the adjacent age groups of the same gender. Among the girls, there are no statistically significant differences at the ages of 12 to 13, and 13 to 14.

Graph 2 and tables 1 and 2 display the results of the motor skill test “Sit Ups in 30 seconds”, characterizing the motor skill capability- repetitive power of the muscles of the frontal abdominal wall. The curve (Graph 2) displays the "Sit-ups in 30 seconds” test, showing a constant and progres-

---

**Table 1. Basic statistic parameters and statistically significant differences among the age categories in motor tests for assessment of the strength indicators in boys from 6 to 14 years old**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Standing long jump (cm) Mean</th>
<th>SD</th>
<th>Sit-ups 30 sek. (n) Mean</th>
<th>SD</th>
<th>Bent arm hang (s) Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 years</td>
<td>101,52</td>
<td>16,58</td>
<td>8,36</td>
<td>4,99</td>
<td>2,87</td>
<td>3,66</td>
</tr>
<tr>
<td>7 years</td>
<td>112,18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18,50</td>
<td>9,86&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,44</td>
<td>3,36</td>
<td>4,14</td>
</tr>
<tr>
<td>8 years</td>
<td>123,80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20,33</td>
<td>11,91&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4,91</td>
<td>4,22</td>
<td>5,31</td>
</tr>
<tr>
<td>9 years</td>
<td>128,61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21,30</td>
<td>12,89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,29</td>
<td>4,53</td>
<td>5,86</td>
</tr>
<tr>
<td>10 years</td>
<td>136,37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21,05</td>
<td>14,64&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,61</td>
<td>5,44</td>
<td>8,4</td>
</tr>
<tr>
<td>11 years</td>
<td>147,80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22,71</td>
<td>15,53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6,02</td>
<td>6,43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8,6</td>
</tr>
<tr>
<td>12 years</td>
<td>158,75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25,78</td>
<td>17,08&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,74</td>
<td>8,07&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10,84</td>
</tr>
<tr>
<td>13 years</td>
<td>168,33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27,72</td>
<td>18,24&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,09</td>
<td>11,69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13,67</td>
</tr>
<tr>
<td>14 years</td>
<td>181,54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26,38</td>
<td>18,94</td>
<td>5,10</td>
<td>15,14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14,77</td>
</tr>
</tbody>
</table>

<sup>a</sup> significance p<0.05 compared with previous younger age group

**Table 2. Basic statistic parameters and statistically significant differences among the age categories in motor tests for assessment of the strength indicators in girls from 6 to 14 years old**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Standing long jump (cm) Mean</th>
<th>SD</th>
<th>Sit-ups 30 sek. (n) Mean</th>
<th>SD</th>
<th>Bent arm hang (s) Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 years</td>
<td>93,22</td>
<td>14,06</td>
<td>6,86&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,00</td>
<td>2,17</td>
<td>3,06</td>
</tr>
<tr>
<td>7 years</td>
<td>103,62&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15,78</td>
<td>9,22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,61</td>
<td>2,52</td>
<td>3,19</td>
</tr>
<tr>
<td>8 years</td>
<td>109,22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15,73</td>
<td>10,65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,27</td>
<td>2,92</td>
<td>3,82</td>
</tr>
<tr>
<td>9 years</td>
<td>118,15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>19,30</td>
<td>11,60&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,49</td>
<td>2,68</td>
<td>3,64</td>
</tr>
<tr>
<td>10 years</td>
<td>122,36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21,24</td>
<td>11,67</td>
<td>6,33</td>
<td>2,71</td>
<td>4,35</td>
</tr>
<tr>
<td>11 years</td>
<td>130,53&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21,07</td>
<td>13,57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5,08</td>
<td>3,52</td>
<td>5,02</td>
</tr>
<tr>
<td>12 years</td>
<td>141,12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20,70</td>
<td>15,96&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4,45</td>
<td>4,04</td>
<td>5,40</td>
</tr>
<tr>
<td>13 years</td>
<td>138,69</td>
<td>24,91</td>
<td>15,35</td>
<td>4,98</td>
<td>4,15</td>
<td>6,36</td>
</tr>
<tr>
<td>14 years</td>
<td>138,28</td>
<td>26,11</td>
<td>15,55</td>
<td>4,97</td>
<td>4,18</td>
<td>5,87</td>
</tr>
</tbody>
</table>

<sup>a</sup> significance p<0.05 compared with previous younger age group

---

*Figure 1. Standing long jump (cm)*
sive advance in its results for every age category for both genders. There is only a regress in the results for 0.61 among the female research participants at the age of 13 to 14. The increase of the results of this test does not remain the same for all age categories. The intensity varies. In some periods it is higher and in some lower. The average increase in the results of the “Sit-ups in 30 Seconds” test for boys at the age of 6 to 14 is 1.32 repetitions and for girls 1.09 repetitions. The result increases from 0.07 to 2.39 repetitions for both genders. The biggest advancement in the results of this test is noted at the age of 11 to 12 among the girls and among the boys at the ages of 7 to 8, and 9 to 10.

For both male and female participants the variability of the motor skill test “Sit-ups in 30 Seconds” is the highest at the age of 6.

The results show that there are statistically significant differences in the results of the boys and girls in all age categories, except when they are at the age of 7.

The LSD-Test, which shows the arithmetic means of the adjacent age categories, has the results showing that there are statistically significant differences among all adjacent age categories for the “Sit-ups in 30 Seconds” test, other than the girls at the ages of 9 to 10, 12 to 13, and 13 to 14 and boys at the age of 13 to 14.

Graph 3 and tables 1 and 2 show the results of the motor skill test “Bent Arm Hang Test” which calculates the muscular strength and endurance of the upper limb and shoulder girdle. The movement of the curve (Graph 3) displays that the test results gradually get better among the male research participants. This is not the case for the male participants at the ages of 13 to 14, because it is the period when they grow bigger and taller. The female research participants’ test results show oscillatory changes as they grow older. The biggest advancement in the results of this test among the female participants noted at the age of 10 to 11 (Graph 3). This is when their test results improve for 0.81 seconds. The oscillatory changes among girls, especially in the period of intensive growth and maturation, are most probably due to the anthropological measurements, body changes and other psychosomatic dimensions.

The results prove us that there are statistically significant differences between the boys and girls of all age categories, benefiting the male participants.

The LSD-Test, which shows the arithmetic means of the adjacent age categories, has the results showing that there are no statistically significant differences among all adjacent age categories for the “Bent Arm Hang” test among the female participants, although there are differences in the arithmetic means. This explains the different results for this test. There are statistically significant differences among the male research participant at the ages of 11 to 12, 12 to 13, and 13 to 14. In the remaining adjacent age categories no statistically significant differences have been found.

The periods when the children are more responsive to certain stimuli and quicker to learn particular skills are also known as the sensitive periods. The increased sensitivity throughout the development of several motor skills during this sensitive period is supposed to have a positive effect on the physical activities that affect those motor skills which is also known as the critical period in the
development of the body. If the positive effects of the workout do not affect the critical periods then there would be no improvement and advancement during the developing process. Not even if we try to work out hard later on.

The results of the research on the average tempo of the body development and growth show that the highest tempo of development is twice as much as the average one, the sub maximal is 1.5 to 2 times as much as the average one and the moderate tempo of development is the one that is not more than 1.5 as much as the average one (Гужаловски, 1984).

Of what we have discussed so far, we can have an idea of the dynamic and the types of changes of the physical strength indicators of the children of both genders at the ages of 6 to 14.

The explosive strength of the lower limbs develops the most at the ages of 6 to 8, 10 to 11 and 13 to 14 for the male participants, where as the females experience this at the ages of 6 to 9 and 11 to 12. The sensitive period for repetitive strength of the muscles of the anterior abdominal wall is between the ages of 6 to 8, 9 to 10 and 11 to 12 for the male participants. The female participants experience this at the ages of 6 to 8 and 10 to 12. The strength in the upper limbs and the shoulder girdle advances the most at the ages of 12 to 14 for the boys and 10 to 12 for the girls.

The natural course of the body development is congruent with the “regulations” of growth and development, motor, functional, mental and emotional maturity. (Bala i sar., 1996., Popović sar., 2006; Bala i Popović, 2007., Popović, 2008; Mraković, et. al, 1996., Horvat i Vuleta, 2002; Vraneković et. al, 2003., Starc et. al, 2010). The physical strength indicators follow the growth curve throughout the analysis (Mišigoj-Duraković, 2008).

In agreement with previous literature, (Ortega FB, et al., 2005) our data suggest that the girls’ fitness levels are generally more homogeneous than boys’ fitness level and a trend towards incrementally higher physical fitness in the boys across age groups, whereas the girls showed stability or a slight increase across ages in physical fitness.

**Why is the development of the physical strength important for the young population?**

Researchers have shown that the jumping and the speed are connected to the bone mass of the hip joint and the labile part of the back (Vicente - Rodriguez et al., 2003, 2004a). The AVENA results show no connection between the jumping and the level of cholesterol in overweighted adolescent boys (Ortega et al., 2004).

The AVENA study results show that the motor skill test “Bent Arm Hang” is related to the level of cholesterol in a positive way, especially with HDL in the children and the adipose tissue, a sum of 6 skin folds calculated according to the Slaughter equation (FB Ortega, JR Ruiz, MJ Castillo, A Gutierrez, 2006). The test proved itself significant in the demonstration of how fitness is linked to the health- a research made on Finnish students at the ages of 9 to 21 years old (Mikkelsson et al. 2006).

The results of this research should be taken into consideration when developing a physical education curriculum, as well as the afterschool activities.

**CONCLUSION**

The results of this research help us conclude the following:

The physical strength gradually increases as the children grow older. The increase is not the same for all age categories. It rather shows periods of higher and lower intensity. The increase is at its highest point at the ages of 10 to 12 for girls and 13 to 14 for boys.

There are statistically significant differences of the physical capabilities between all age categories of boys and girls, benefiting the male research participants.

It would be practical to conduct such researches in all schools in the Republic of Macedonia where the physical education teachers should be the ones to identify children with a low fitness level, as well as the talented ones.
REFERENCE


Correspondence:
Serjozha Gontarev
Ss. Cyril and Methodius University in Skopje
Faculty of Physical Culture,
Zeleznicka b.b.
1000, Skopje, Macedonia
e-mail:gontarevserjoza@gmail.com
РАЗВОЈНИ ПРОМЕНИ НА СИЛОВИТЕ ПОКАЗАТЕЛИ КАЈ УЧЕНИЦИТЕ ОД ОД ДВАТА ПОЛА НА ВОЗРАСТ ОД 6 ДО 14 ГОДИНИ

УДК: 796.431.015.572-057.874
(Оригинален научен труд)

Серјожа Гонтарев, Вујица Живковиќ, Мilan Наумовски, Руждија Калац
Универзитет „Св.Кирил и Методиј“ - Скопје, Факултет за физичка култура, Скопје, Р. Македонија

Абстракт
На примерок од 4.162 испитаника, јоделени во 9 возрасни гррупи од маки и 9 возрасни гррупи од „енски пол во распон од една календарска година, реализирано е испитување со основна да се утврди развојната тенденција на експлозивната сила на долните екстремитети. За реализирање на целите на испитувањето примерок е поделен на мажки и женски пол од возраст од 6 до 14 години. Изведени се тестови за вложба и кваалитет на мускулна сила. Експлозивната сила на долните екстремитети испитувана со тестот „скок во далечина од местото“. Во свите возрасни квадрети за експлозивната сила испитани се: основниите статистички параметри, додека различиите помеѓу возрасните квадрети и полот се утврдени со мултиваријантна и униваријантна анализа на варијаната (МАНОВА и АНОВА) и ЛСД - теорија. Експлозивната сила на долните екстремитети испитувана со тестот „скок во далечина од местото“. Растот е нелинеен во свите возрасни квадрети и се замалуваат со волата на возраст. За девојките најголема акселерација се забележува меѓу 11. и 12. година, кога исполнети испитаниот тест. За момичета најголема акселерација се забележува меѓу 13. и 14. година. Момичета во свите возрасни квадрети и испитувани се зголемуваат се зголемуваат во возраст.

Ключни зборови: сила, експлозивна, релейшйивна, мускулна сила и издржливост