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DYNAMICS OF DEVELOPMENT AND EVALUATION OF AGILITY IN SCHOOL EDUCATION (1st-12th GRADE)

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ABSTRACT

Physical activity is an important criterion for a healthy lifestyle and a prerequisite for improving the motor abilities of adolescents.

The aim of this study is to establish the level of development of physical quality agility in all stages of school education. In order to fulfill the set aim of the research, we used sports-pedagogical testing. The research was carried out with 232 pupils from 1st to 12th grade. We used variation analysis and comparative analysis with t-criterion of Student for independent samples to process the study results. Following the dynamics of the development of the studied indicator between the different classes, we report a positive increase six times, and a decrease in the result - three times (from 2nd to 3rd grade; from 7th to 8th grade and from 10th to 11th grade). Between grades 5th – 6th and 8th – 9th there was no increase in the results. The average number of points reported for each class ranged between 9 and 13 points, which according to the evaluation table means a "GOOD" assessment of agility development. Our study shows that the dynamics of the mean level of the researched indicator in the age aspect changes regressively, with the values decreasing from 1st to 12th grade. Comparing the changes in the mean values of pupils divided by class and gender, we established that, overall, boys are faster than girls when performing the test.

***Key words**: agility, pupils, testing, quality evaluation*

INTRODUCTION

The educational process of physical education is aimed at mastering the knowledge, skills and habits, developing the motor, moral, and volitional qualities of the adolescents. In turn, physical fitness in the training process aims at a versatile physical development, enhancing the functionality of all organs and systems in the human body, strengthening and stiffening of the child's organism from the beginning of school age (Borukova, 2019).

Pupils' insufficient motor activity in the modern technological world leads to disruptions in the functioning of the various systems of the child's organism, reduces the ability to work, and impairs health. Promotion of physical activity and physical fitness among children is an important public health goal for governments, health authorities and other local public health stakeholders (Jarani et al. 2015). The school environment plays a crucial role in providing opportunities for children to engage in physical activity (Gallotta et al., 2009) and it serves as an ideal setting for school-based physical activity intervention (Kriemler et al., 2011). According to Lee, Burgeson, Fulton, Spain, (2007), Sallis, (2004), physical education must be consid-

ered as a powerful and valuable setting for structured interventions affecting health outcomes, including physical fitness and physical activity among children.

In the theory of physical education, the different sides of motor abilities are defined as motor qualities – speed, strength, endurance, flexibility, and agility (Rachev et al., 1998; Jeliazkov, Dasheva, 2017).

Agility is a complex motor quality and reflects the body's ability to cohere (coordinate) individual movements and actions across time, space and effort, adequate to the motor task (Zhelyazkov, Dasheva, 2017; Hadzhiev et al., 2011). Metikos et al., (2003) are of the opinion that it is the human ability to displace the body in space quickly and efficiently under the conditions of repeated performance of sudden stops and changes of direction, but Young and Farrow (2006) defined it as a rapid whole body movement with change of velocity or direction in response to a stimulus. According to Gabbett et al. (2008) and Sheppard et al. (2006) the cognitive component of agility is very important. However, the mechanics associated with agility are also essential for skill execution. Change-of-direction speed helps describe these mechanics, in that it incorporates the ability to accelerate and decelerate rapidly, in addition to changing direction (Young, Farrow, 2006).

The level of development of agility is determined by a number of factors (Kleshchev, 1997). Of great importance are the highly developed muscle sensation and the flexibility of the nervous processes. The degree of their manifestation depends on the speed of formation of coordination bonds and the speed of transition from one condition and reaction to another. According to the author, the basis of agility is coordination abilities, which mean the ability to quickly, accurately, appropriately and effectively solve motor tasks (Bakulev, 2006; Lyah, 2010; Kleshtev, 1997).

According to Lyah (1983) and Hadzhiev (2009) motor coordination is to some extent genetically determined. Dimitrova (2014) points out that the coordination of movements has a heredity coefficient of Holzinger 45%, which means that the possibility of manifestation of phenotypic factors is significant.

It has been established that in different age periods, the development of coordination abilities takes place in different directions and at different times. For example, at the age of 7-8 years motor coordination is characterized by instability of speed parameters and rhythm. In the period from 11 to 13-14 years the accuracy of differentiation of muscular efforts is increased and the ability to reproduce the set tempo of movements is improved. The 13-14-year-old boys have a high ability to master complex motor coordination. At the age of 14-15 there is a slight decrease in spatial analysis and coordination of movements. In the period 16-17 years, the improvement of motor coordination to the level of adults continues, and the differentiation of muscular efforts reaches an optimal level (Chaikin, 2013; Holodov, Kuznetsov, 2000).

The movements that are used within particular change-of-direction speed tests are wide and various. As a result, numerous tests have been developed to assess change-of-direction speed in athletes (Lockie et al. 2013). Some examples include: 5-0-5 for rugby league (Gabbett et al., 2008) and soccer (Maio Alves et al., 2010) players; Illinois agility run for rugby union (Jarvis et al., 2009) and soccer (Vescovi et al., 2006) players; T-test for soccer players (Sporis et al.,2010); pro-agility shuttle for American football (Sierer et al., 2008) and soccer (Vescovi et al., 2006) players; and 3- cone drill for American foot-

ball (Sierer et al., 2008) and rugby league (Gabbett et al., 2008) players. While the value of these tests is widely acknowledged, there are some limitations and they may not be relevant to the complex change-of-direction movement demands of many sports (Gabbett, Benton, 2009). There are also few change-of-direction speeds tests that assess the ability to sharply change direction of movement. This is pertinent, as the space used for movements within a change-of-direction speed assessment are important considerations for correctly administering a test (Metikos et al., 2003).

In the field of physical education, there are various tests to assess the agility and coordination abilities of pupils. The most commonly used are: throwing a ball at a target, running on a low gymnastic bench (Grozdeva, 2010), orientation shuttle run test for speed, hanging target throw to assess upper limb response orientation ability, low jump to assess kinesthetic differentiation ability, backwards ball throw at a target (Gallotta, 2010, Jarani et al. 2015, Tankoucheva, 2019), T-test for agility (Borukova, 2019, Miladinov et al., 2019).

Some authors (Zamashkin, Tolstova, 2013, Pisarenkova, 2010,) are of the opinion that the improvement of coordination abilities and other physical qualities at school age is an urgent task of the school process. In addition, the primary school age is the most favorable in this respect.

Therefore, it was of interest to us to trace the development of agility during the age periods of the school education, as well as the influence of physical education classes in Bulgarian schools.

The aim of our study is to establish the level of development of physical quality agility in all stages of school education. In order to achieve the aim, we set the following *tasks*:

- ✓ To conduct a testing of the pupils from 1st to 12th grade.
- ✓ To process and analyze the obtained results.
- ✓ To make a qualitative evaluation of the level of development of the agility quality of the studied pupils.

METHODOLOGY

The research was aimed at exploring the main indicators of physical fitness of pupils from 1st to 12th grade. To realize it, we used a test battery which bears information about the main indicators of physical ability. The battery includes five tests – *running 30 m, standing long jump, medicine ball throwing (1 kg), running 200 m (shuttle running), T-test for agility and spatial coordination* (Miladinov, et al., 2019).

The first four tests are standard and are applied in physical education and sport classes. The only new test is that for agility and spatial coordination. Therefore, in this article we will present and analyze precisely the data from the study of all pupils for this test only, and the results of the other tests and the relationship between them will be subject of another publication.

T-test description: Four small rubber hoops (15-20 cm in diameter) are placed in the shape of the letter T (Figure 1). There is one tennis ball in each hoop. Performance: The pupil stands behind the hoop at the start/finish position in a standing position. At the starting signal, the pupil bends down, takes the ball and moves to the rest of the hoops in the direction indicated with figures from 1 to 6 (see Figure 1). Pupils take the ball from every following hoop, leaving the one they have taken from the previous hoop. The recording ends as soon as the ball touches the start/finish area of the hoop. Measured with accuracy of up to 0.01 sec. The student is entitled to only one attempt.

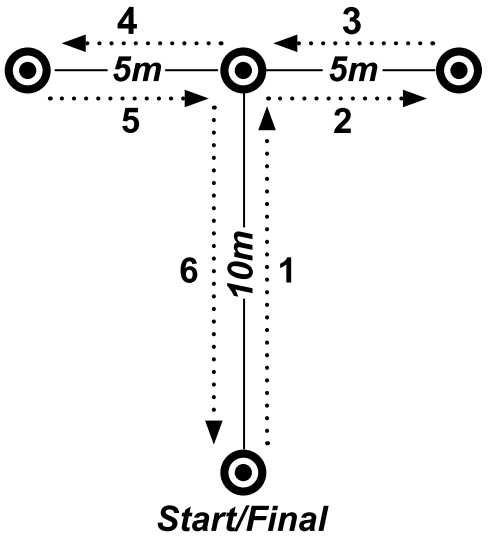

Figure 1. *T-test for Agility*

Limitations of the research

The research was carried out within the framework of a national scientific project of National Sports Academy "V. Levski" and the Ministry of Education and Science for the study of the physical capacity of pupils from secondary schools in the Republic of Bulgaria. In this study, we only present data that was personally obtained from the researchers – authors of this article. The device used to detect the time to perform the test is a handheld chronometer. Unfortunately, in Bulgarian schools there is no possibility to use modern electronic equipment for measuring time, which at this stage does not allow us to make our study more in-depth.

Research methods and indexes

In order to fulfill the set tasks and aim of the research, we used the following methods: *study of the specialized literature and sports-pedagogical testing*.

Procedure

The research was carried out in October 2018 at Secondary School "Chernorizets Hrabar" in the town of Plovdiv. The sport-pedagogical tests were applied at school within the regular physical education and sports classes. We studied 232 pupils, including 123 boys and 109 girls. The pupils participated voluntarily in the research. We studied one class of students from 1-st to 12-th grades, ages 7 to 18. Before the test, detailed instructions and demonstration were provided. To perform the test, we used the necessary equipment: a stopwatch, 4 small rubber hoops, 4 tennis balls. Each participant performed the test with only one attempt.

Data analysis

The results from the research were processed with *math-statistical methods*: variation analysis and comparative analysis with t-criterion of Student for independent samples (Gigova, 2002). All analyses were processed and illustrated with the SPSS statistical package, version 19.0 and Excel 2013.

RESULTS AND ANALISIS

The coefficient of variation in almost all grades from the primary and pre-high school stages of the major educational degree showed the approximate uniformity of the values in the groups. It ranged from 12.2 to 17.4%. Only the 5th grade showed homogeneity of values, with a coefficient of variation of 9.6% (Table 1).

Table 1. *Variation analysis of the indicator "T-test of agility" in primary and pre-high school stages of the major educational degree (1st-7th grade)*

Grade	n	Mean	min	max	R	S	V%	As	Ex
1-st	18	20.63	17.96	27.63	9.67	2.78	13.51	2.03	1.69
2-nd	20	19.38	15. 89	**29.93**	**14.04**	3.32	17.13	4.80	2.01
3-rd	20	20.00	16.15	27.15	**11.00**	3.17	15.88	-0.29	0.77
4-th	25	18.28	14.74	22.06	7.32	2.23	**12.20**	-1.31	0.29
5-th	19	17.43	14.37	20.12	5.75	1.68	**9.64**	-1.19	-0.08
6-th	22	17.43	**13.08**	21.78	8.70	2.24	12.89	-0.57	0.17
7-th	17	16.04	13.86	24.59	10.73	2.78	**17.38**	4.83	2.03

Overall, there were large differences between the minimum and maximum values in the different classes, but a more significant impression was the big difference for pupils in the 2nd and 3rd grades of 14.04 and 11.00 seconds. The best result was reported for the 6th grade pupil (13.08 sec) and the lowest for the 2nd grade pupil (29.93 sec). In tracking the dynamics of the averages for the age-appropriate agility test for pupils from the primary and pre-high school stages of the major educational degree, there was an improvement in the results from 1st to 7th grade – from 20.63 sec. up to 16.04 seconds. In our opinion, this is logical, due to the natural age of the children and the development of their spatial orientation and coordination. Exceptions are the pupils from the 3rd grade, where the results were worse.

The data for all grades in the high school stages of the secondary educational degree showed approximate homogeneity of the groups with a coefficient of variation above 12% (V is 12.8 to 16%). The difference between the best and worst scores in the different classes ranged from 7.80 to 9.42 seconds, with a 10th grade pupil completing the test in the shortest time (12.92 seconds), and the 11th grade the slowest - 22.88 sec. (Table 2).

Table 2. *Variation analysis of the "T-test of agility" in high school stage of the secondary educational degree (8th-12th grade)*

Grade	n	Mean	min	max	R	S	V	As	Ex
8-th	23	17.37	14.06	21.86	7.80	2.23	12.83	-0.16	0.72
9-th	24	17.34	13.92	22.21	8.29	2.33	13.46	-0.54	0.36
10-th	23	16.23	**12.92**	22.03	9.11	2.15	13.25	2.45	1.39
11-th	12	16.75	13.46	**22.88**	9.42	2.48	14.80	2.61	1.29
12-th	9	16.00	13.40	21.60	8.20	2.56	16.01	2.23	1.39

The analysis of the mean values reported for the 8th to 12th grade pupils again showed a slight improvement in the results. In the high school stages of the secondary educational degree, the values were quite close between the different classes (from 17.37 to 16.00 sec).

When we compared the average values of the classes of the two grades of school education, we noticed a certain retention in the result with similar values from the 1st to the 3rd grade, and then, at the end of the primary education, in 4th grade, the score improved (from 20.63 to 18.28 sec.). This tendency was again evident in the 5th and 6th grades (retention) and improvement at the end of the 7th grade pre-high school stage (Figure 2).

In the first two years in high school stage of the secondary educational degree (8th and 9th grade) pupils showed the same results as those in 5th and 6th grades (17.43 sec) and much lower than in 7th grade (16.04 sec). This, in our view, is not a good sign of the level of agility development and more work is needed to develop and improve this quality. The results we reported at the end of secondary education (10th-12th grade) were also close in value. Compared to the previous classes, their results were improving.

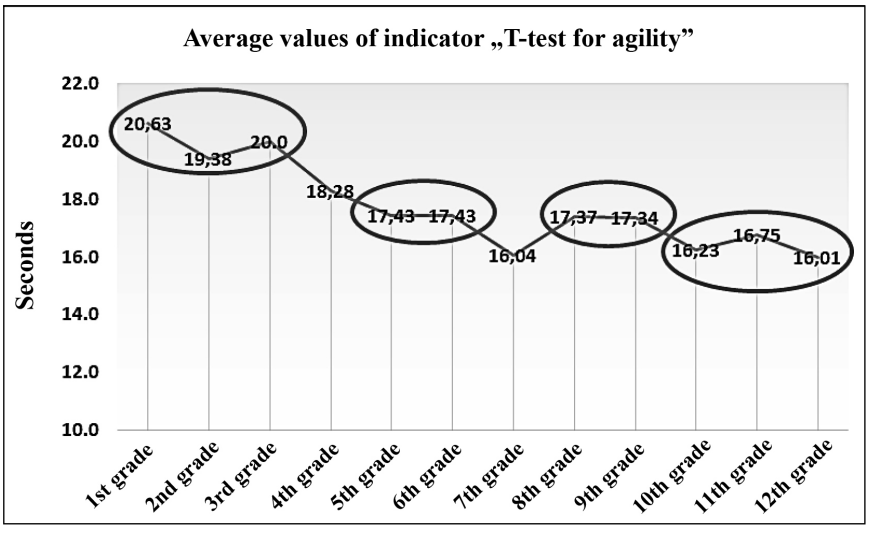

Figure 2. *Dynamics of mean values for pupils from 1st to 12th grade*

Figure 3 shows the differences between the mean values of the "T-test of agility" in boys and girls of all the classes studied. It can be seen that in most classes, girls had higher values than boys, which for a particular test, however, means lower performance. From our personal observations during pupils testing, we can state that there are three main reasons for this:

- slow movement between stations (slower velocity ability – speed),
- inaccurate placement of the balls in the hoops (subject agility),
- faults in the sequence of placing the balls in the hoops (weak spatial orientation).

The exceptions are grades 3rd and 6th, where girls 'scores were better than boys' scores.

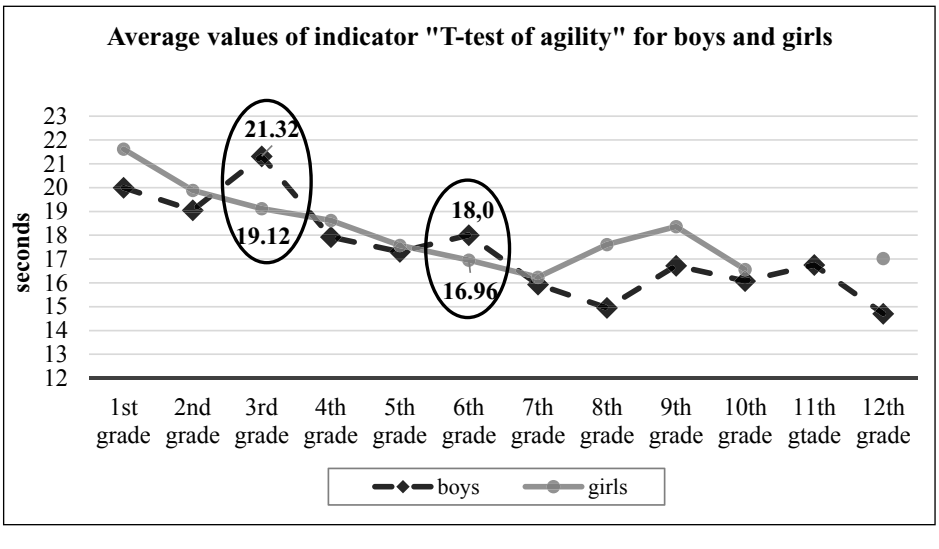

Figure 3. *Dynamics of average values for boys and girls from 1st to 12th grade*

The results obtained are related to the fact that in all periods of school age girls and boys have individual characteristics in the level of development of agility. Its various manifestations have a certain age-dynamics related to the biological development of children, as the highest levels of their natural growth are in pre-puberty. For example, gender differences in the ability to spatial orientation are relatively low in the age group of 7 to 11 years. This is observed in favor of boys aged 12 years (Hirtz, Starosta, 2002). The highest growth rates of the motor response are achieved between the ages of 7 and 10 years. At the age of 13, gender-specific differences were found in favor of boys (Hirtz, 1985).

Following the dynamics of the development of the studied indicator between the different classes, we report a positive increase six times, and a decrease in the result was three (from 2nd to 3rd grade; from 7th to 8th grade and from 10th to 11th grade). Between grades 5th – 6th and 8th – 9th there was no increase in the results (Figure 4).

A deeper insight into the values of the t-criterion of Student shows that for almost all indicators t_{emp} is less than $t_{critical}$ ($t_{critical} = 2.05$) (Figure 4). This gives the reason for the high guarantee probability ($Pt \geq 95\%$) that the null hypothesis is confirmed, according to which the observed improvement in the results is not significant and can be explained by random reasons (positive growth, but insignificant between grades 1st/2nd; 4th/5th; 6th/7th; 9th/10th and 11th/12th grade).

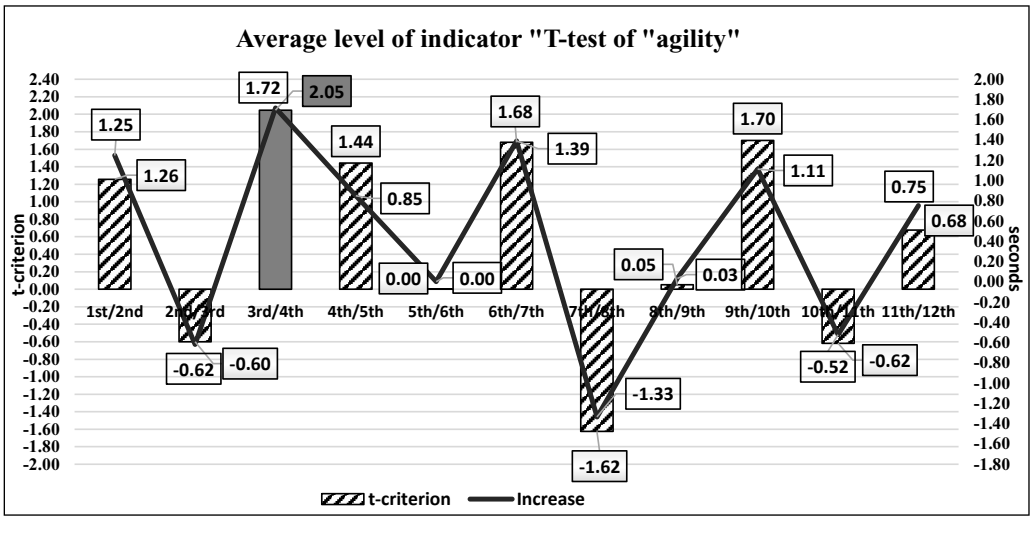

Figure 4. *Increase and significance of differences between average levels of studied indicator for pupils from 1st to 12th grade*

We can also see in the figure that the t-criterion of Student had a value of 2.05 only for the increase between the 3rd and 4th grade. This gives reason, in terms of the level of agility development, to reject the null hypothesis and to consider the alternative, according to which the improvement in the result between these classes is statistically significant.

Evaluation of the level of physical quality agility of pupils from school education we prepared according to the developed national system for assessing the physical capacity of pupils from 1st to 12th grade in the Republic of Bulgaria. In it, the test results tables are divided by age and gender, and a 20-point scale is used to evaluate these results. The following guidelines were followed in the evaluation:

- First step – is to determine the number of points for the test result, depending on the gender and age of the pupils.

- Second step – is to equate the number of points obtained with the six-point rating system (Miladinov et al., 2019).

Figure 5 presents the mean evaluation of the results of the study in boys and girls. Almost all pupils' results fell into the grading scale from 8 to 14 points. They received evaluation of "Good 4". Only the score of the boys from the 3rd grade was lower – "Satisfactory" (7.4 points).

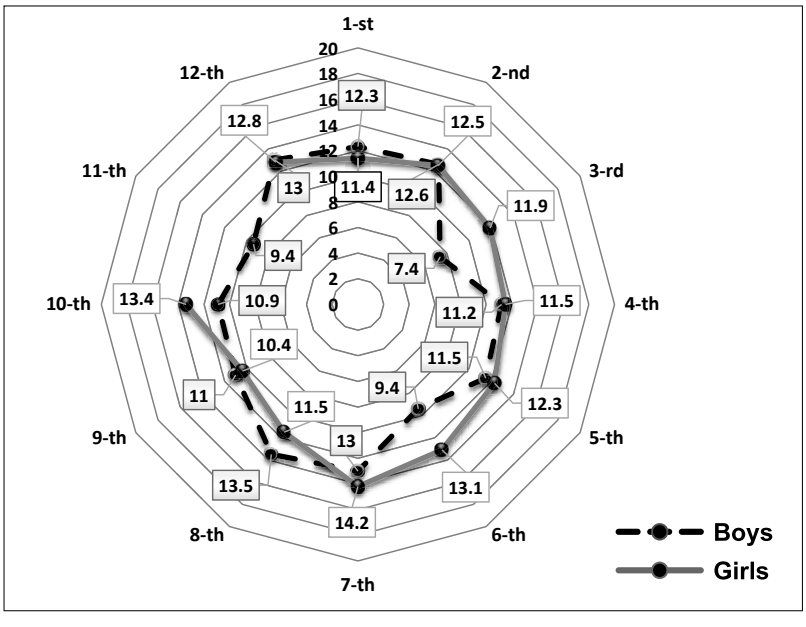

Figure 5. *Evaluations of the results of pupils in school education (1st to 12th grade)*

DISCUSSION

The results of the study show a tendency to improve agility at different ages. It is most noticeable in pupils from primary and pre-high school stages of the major educational degree (from 7 to 13 years), which we believe is natural, on the one hand, the natural development of children, and on the other – it is related to the sensitive periods of development. For coordination abilities as a component of agility, these periods are between 7 and 12 years (Dimitrova, 2014) and after puberty, but the highest indices appear at the age of 13-14 years (Borukova, 2019). A statistically significant difference, however, is observed only between 3rd and 4th grade pupils. This is probably related to the development of the motor analyzer at this age - 10-11 years. It has been found that each age group has sensitivity to the acquisition of specific motor skills (Weineck, 2001).

The comparative analysis shows poorer results for pupils in the first two years of high school stage of the secondary educational degree (8th and 9th grade). This shows a low level of development of agility and spatial coordination in this age group. In the following age periods (10th – 12th grade) there is again a tendency to improve the results, which, however, is not statistically significant. This may be due to the following facts: insufficient sports facilities; conducting the physical education classes by class supervisors and the lack of specialists for extra hours. They can affect negatively the degree of mastery of the necessary motor skills and habits as well as the development and manifestation of basic physical qualities, including agility (Tankousheva, 2019).

There is no difference in the evaluations obtained (based on the results achieved) between the separate classes. This shows an insufficiently good level of agility development at different ages. Therefore, more attention

should be paid on strategies focusing on the quantity and quality of physical education classes (Sallis et al., 2012; Veugelers, Fitzgerald, 2005; Wang, Pereira, Mota, 2005). Physical education should provide encouragement to increase physical activity and promote activity and exercises that aim to improve a broad range of physical fitness parameters including both health (e.g. cardiovascular fitness, flexibility and body composition) and skill-related (e.g. agility, balance, power, speed and coordination) physical fitness (Jarani et al., 2015).

Considering that children are in the maturation process, affecting their capability to learn particular motor skills, as well as the increasing movement's complexity, it is essential to develop coordination during early school age. An effective training program for children must take into account the psycho-physical particularities of each age range, in order to focus on and to exploit to the maximum the specific age-related motor learning abilities (Ricotti, 2011).

We believe that the T-test for agility has a high applicability because, like other similar test batteries, it is effective for a wide age range, from children of primary school age (Chang et al., 2013) to adolescents aged 13-16 years (Budde et al., 2008). Demonstrating their effectiveness, it will be important to promote implementation of coordinative multilateral physical education programs, which in turn can have an important impact on pupils' health and physical fitness (Gallotta, 2014, Jarani et al., 2015).

CONCLUSIONS

Our study shows that the dynamics of the mean level of the researched indicator in the age aspect changes regressively, with the values decreasing from 1st to 12th grade, which means that the time for completion of the T-test for agility is improving. However, this improvement is only statistically significant for the increase of pupils in grade 3rd through grade 4th.

The comparative analysis of the mean values of the pupils divided by classes and gender enables us to claim that in the performance of the T-test the boys are superior to their female peers. Exceptions are the results reported for 3rd and 6th grade, where the girls are faster.

The small positive increments of the results between classes are insignificant. This, in our opinion, is due to three less well-developed components of agility: velocity ability – speed; subject agility and spatial orientation.

To improve these factors, we recommend extra working in physical education classes using the following examples: gymnastic complexes of warm-up exercises with small devices – ball, stick, rope, hoop, etc.; gymnastic moveable games with competitive character; dance movements and exercises from aerobic gymnastics.

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