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Study regarding the development of agility skills of students aged between 10 and 12 years old

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Abstract

Physical education classes, at primary school level, are based on developing psychomotor skills, out of which the most important are coordination and speed. At this age, skills like coordination, speed or the two combined, namely agility, are developed the best. Agility is an important characteristic of motor development, a quality needed to maintain and control body position while changing direction.

Our study focuses on a primary school class that practices physical education and we tried to see how they develop their combined coordination and speed skills. We choose to use a set of six agility tests that analyze the main components of agility like speed of movement, lateral movement, balance, coordination: Illinois Agility, Agility T-test, Agility Cone, Box Drill, AFL Agility, Arrowhead agility test and so on. After using some specific programs to develop speed and coordination we used the same tests and saw the improved results. We had two groups that we worked with, first group, the experimental group, included 16 students (age 10±1.3 years; body mass 40.3±5.4 kg; body height 142.3±5.1); the control group, included 19 students (age 10±1.6 years; body mass 43.6±3.4 kg; body height 138.5±4.7).

Results showed that the experimental group developed skills like speed, coordination and agility easier than the other group. Statistically significant differences were determined within the experimental group both in the initial and in the final tests ($p<0.05$), also significant differences were discovered between the experimental and the control group in the final measurement ($p<0.05$).

Conclusions. The Hypothesis of this study was confirmed - participation of young children in special programs for developing agility skills can prove to be very constructive for their future by developing skills like speed, coordination, lateral movement etc.

***Key words**: speed; coordination; agility; psychomotor skills; physical education*;

Rezumat

Activităţile de educaţie fizică şi sport, la nivelul ciclului primar, sunt axate pe dezvoltarea deprinderilor psihomotrice, u na din cele mai importante deprinderi psihomotrice fiind coordonarea şi viteza. La acest nivel de vârstă, deprinderi ca şi coordonarea, viteza sau combinaţia dintre acestea, agilitatea, sunt foarte bine dezvoltate. Agilitatea este o importantă caracteristică a dezvoltării motrice, deprindere necesară menţinerii controlului poziţiei corporale atunci când schimbăm direcţia de deplasare.

Prezentul studiu se focusează pe o grupă la nivelul ciclului primar practicanţi de activităţi motrice la care am încercat să observăm cum decurge dezvoltarea deprinderilor combinate de coordonare şi viteză. Am decis să utilizăm un set de şase teste de agilitate care să analizeze principalele componente de agilitate ca viteza de deplasare, deplasarea laterală, echili brul, coordonarea: Illinois Agility, Agility T-test, Agility Cone, Box Drill, AFL Agility, Arrowhead agility test şi asa mai departe. După folosirea unor programe pentru dezvoltarea vitezei şi coordonării am utilizat aceleaşi teste şi am observat rezultatele îmbunătăţite. Studiul a avut două grupe cu care am lucrat, primul grup, cel experimental, a fost format din 16 elevi (cu vârsta cuprinsă în intervalul 10±1.3 de ani, greutatea de 40.3±5.4 kg, înălţimea de 142.3±5.1); grupul de control, a fost format din 19 elevi (cu vârsta cuprinsă în intervalul 10±1.6, greutatea de 43.6±3.4 kg; înălţimea de 138.5±4.7).Rezultatele au arătat că

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grupa experimentală a dezvoltat mult mai uşor deprinderi ca viteza, coordonare şi agilitate decât celălalt grup. Statistic am găsit diferenţe la grupa experimentală atât la testarea iniţială cât şi la testarea finală ($p<0.05$), de asemnea diferenţe semnificative au fost descoperite între grupa experimentală şi grupa de control la testarea finală ($p<0.05$).
Concluzii. Ipoteza studiului a fost confirmată, participarea tinerilor copii în programe speciale de dezvoltarea a deprinderii de agilitate poate fi foarte constructivă în dezvoltarea deprinderilor de viteză, coordonare, deplasare laterală etc.
***Cuvinte cheie**: viteză, coordonare, agilitate, deprinderi psihomotrice, educaţie fizică.*

1. Introduction

Nowadays the sports science community does not agree on a clear definition of agility, but classically agility is defined simply as "the ability to change direction rapidly" [1] or "the ability to change direction rapidly and accurately" [2]. Recent scientific papers try to complete the agility definition adding "whole body change of direction as well as rapid movement and changing direction of body parts" [3].

Others define agility as "the ability to maintain or control body position while quickly changing direction during a series of movements" [4].

Most researchers consider speed and agility complex psychomotor skills [5]. Those skills imply moving the whole body as fast as possible, thus agility has an extra characteristic of changing direction. When defining speed most researchers refer to the shortest time required for an object to move through a fixed distance, the definition resembles the definition of velocity but without mentioning the direction of movement [6].

When we talk about agility moves, the speed skill for moving upfront, left or right is not constant over the entire distance; therefore it is divided in some specific phases: speed of acceleration, maintenance of maximum speed and speed of deceleration [7].

In many sports scientific research, agility is often defined as the ability to change direction rapidly [8]. Agility can be present in many forms, from moving one single part of the body like simple footwork to moving the entire muscular system in other direction while running with a high speed.

Nowadays sports research concluded that speed is an important component of the agility skill but the old definition of agility is too basic and simplistic, because agility includes more fundamental components like balance, coordination, the ability to adapt and react to a change of the environment [9]. Some specialists consider agility as a complex motor skill and classify agility among mixed physical capabilities [10]. Although speed is a component of agility the two concepts must not be confused or considered synonyms; agility should be superior to both speed and coordination. Past researchers define agility as the ability to change direction, start or stop the movement with speed [11,12]. Newer investigation claims that speed and agility represent independent physical abilities and for their development a high degree of muscular specificity is required [13]. Anticipation and decision making also play an important role in the development of agility [14]. A correct form of evaluating agility must take in consideration the rapid change of direction, acceleration and fast stopping.

Agility involves different moving mechanism than those used by track sprinters for example, and it is employed more in sports games and martial arts [15]. Agility needs change of direction and is different from straight line speed performance [16]. Other components of agility are acceleration and deceleration, those involved in change of direction movements and those that help improving the performance, so specific skills that should be trained separately [17].

In team sports when we talk about agility we are not resuming only to the ability to change direction of movement, but also to the capacity of anticipating opponent moves and counteract, read and react to specific situation appearing during the game [18].

According to scientists, the role of the coach in enhancing an athlete's performance is very important the increased indices of speed, strength, coordination and balance being able to contribute to achieve sports performance [19].

New research tried to provide an exact definition for agility - "rapid whole body movement with change of velocity or direction in response to stimulus coming from the environment" [20]. So in team sports, agility skills are not limited to the rapid change of direction but also include abilities like perception and decision making, as well as speed of expression, proving that agility in the context of team sport is multifunctional [21].

The definition that is generally accepted for agility is "a rapid whole-body movement with change of running direction in response to a stimulus" [22]. Agility involves moving the upper body segments in order to change the running direction rapidly without losing balance [23].

Many sport games have in their basic movements different changes of direction. The ability used in this basic movement is agility. Scientists found that there are a lot of similarities in performance in agility t-test and 50 meters sprint not depending on gender [24].

Coordination and movement control are important in agility, but apart from this, other components

affect the level of agility such as dynamic balance, mobility of joints, power and flexibility, resources of energy, strength, speed and biomechanical structure of movement [25].

Other researchers define agility as "the ability that makes possible for an athlete to change direction of movement, make quick stops and make fast, smooth, efficient and repetitive movements" [26].

In a wider context agility can be defined as "speed coordination" and in some specific sports the term "specific agility" is used because it has special moving patterns [27].

In developing agility skills specialists use some basic walking techniques, running techniques, quick changes in the direction of movement, jumping and landing [28]. Plyometric training, counter-movement, jumping and drop jump can positively affect vertical jump development, as well as the level of agility [29].

Agility is considered to be a dynamic movement requiring high muscle power and it is assumed that jumping and agility performance are closely related [30]. Some specialists stated that "both maximal jumping and sprints are generally considered as dynamic movements requiring high muscle power and they should be related" [31]. Agility needs rapid force development and high power output, and also the ability to efficiently use the stretch-shortening cycle in ballistic movements [32]. Also, lower limbs strengthening have been correlated with agility [33].

2. The aim of the study

The present study had as main objectives the development and analysis of the impact agility training has on children's coordination and basic motor skills. We started the study with the presumption that special development of speed, lateral movement and other directions movement can improve the agility skills in children.

3. Materials and methods

In our study we tried to develop and then test the agility skills at primary school level using different specific moves that agility requires. In order to do so we built our experiment using two groups, one group being the experimental group and the second being the control group.

Location and subjects

Our study, with the main topic "developing agility skills at primary school level", took place in Bucharest, at School No. 179, involving two classes: class IV-A – as experimental group, with an effective of 16 students, 7 girls and 9 boys, and class IV – B – as the control group, with an effective of 19 students, 12 girls and 7 boys, both groups having same age and physical development. The experiment took place between October 2014 (Initial test) and March 2015 (Final Test). In the experimental group we worked with a special twelve -week training program, two times a week with a one week break in the middle of the study; the program was mostly focused on developing agility skills using different kinds of movement specific to agility, speed and coordination. The control group maintained regular physical education classes activities during the experiment.

We selected a set of six tests from the vast agility literature that involve coordination, speed, lateral movement, backward running, shuffle and speed of movement, skills that are specific to many popular sports in Romania that we want the kids to learn such as football, basketball, volleyball, handball etc. The tests were carried out during the week prior and following the training program at the same time of the day in the same indoor conditions.

After finishing the 12-week training program for developing the agility skills, we tested our two groups using some specific agility test selected for analyzing the lateral movement, speed of movement, coordination, and speed; the test used were: Agility T-test, Illinois Agility Test, Agility Cone Test, Box Drill Agility Test, AFL Agility Test, Arrowhead Agility Test.

Tests used for the evaluation of agility

Agility T-Test

We choose this particular test because it evaluates the speed, lateral movement and also the coordination and agility. This test requires the athlete to touch a series of cones set out in "T" shape whilst side stepping and running as fast as possible.

To do the test we needed: a flat surface, 4 cones and a stopwatch. The cones are placed in "T" shape, cones A,B and C are placed in straight line 5 m apart from each other, and cone D is placed 10 m apart

from the middle cone B, in such a manner that the 4 cones form a "T".

The student starts at cone D at the base of the "T" at the "go" signal, runs forward to cone B, side steps 5 meters to cone A and touches it, side steps 10 meters to cone C and touches it, side steps 5 meters to the middle, cone B and touches it and then runs backwards to the base of the "T" touching cone D. The stopwatch stops when the student reaches cone D.

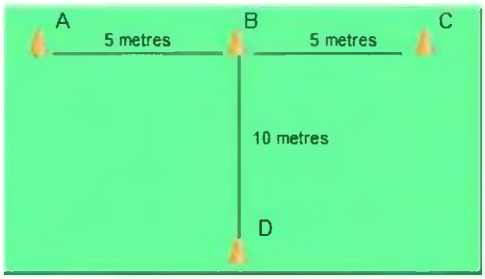

Fig. 1. Agility T-Test
(http://www.brianmac.co.uk/tdrill.html)

Illinois Agility Run Test

The objective of the Illinois Agility Run Test [34] is to monitor the development of the athlete's agility. This test evaluates the speed of movement, zigzag crossing, speed and agility.

To do the test we need: a flat surface, 8 cones and a stopwatch.

The test starts with the student lying face down on the floor at the "Start" cone. At the command "go" the student starts the test and the trainer turn on the stopwatch. The student rises from the ground and starts running following the red line route shown in the diagram towards the finish. The stopwatch is stopped when the student passes the finish cone.

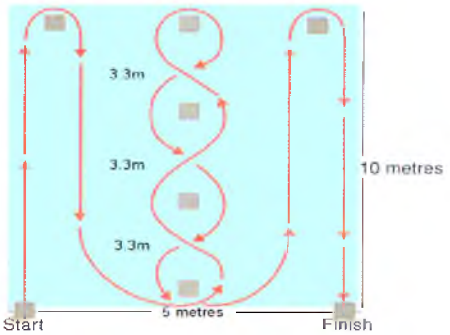

Fig. 2. Illinois Agility Run Test
(http://www.brianmac.co.uk/illinois.html)

Agility Cone Test

The agility cone test or the "cross agility" test is a method of evaluating agility that uses lateral movement, speed and agility.

The cones are placed on the ground in cross position as shown bellow, with a 5 meters distance between them. The student starts from the centered cone 1 with lateral movement to the second cone situated in the right, returns to the center cone and touches it and then repeats the structure with cones 4 and 5.

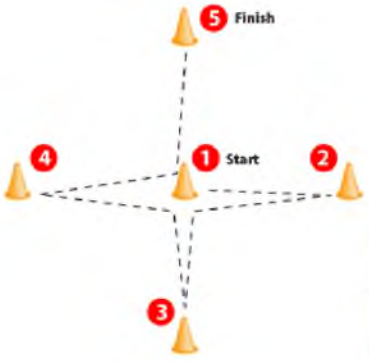

Fig. 3. Agility Cone Test
(www.topendsports.com/testing/tests.html)

Box Drill Agility Test

This is an agility test that demands four movement stiles: running forward, shuffle, backpedal, turn and sprint. This test evaluates the speed of movement, the lateral movement, running backwards and speed.

Four cones are placed in square formation as shown below; the student starts from the first cone sprinting to the second cone, between cones 2 and 3 he shuffles, between cones 3 and 4 backpedals and after passing the 4th cone turns and sprints until the first cone.

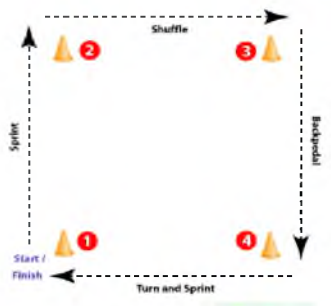

Fig. 4. Box drill Agility test
(www.topendsports.com/testing/tests.html)

AFL Agility Test

Specific for this test is the slalom between cones; it has been developed by the Australian Football League. This test involves running inside and outside through cones covering a distance of about 40 meters in total.

For the test we need: a flat surface, 5 cones and a stopwatch.

The cones are arranged as shown in the scheme below; the student starts from the start line in the center, runs until the last cone and afterwards slaloms as shown in the image until he reaches the finish line.

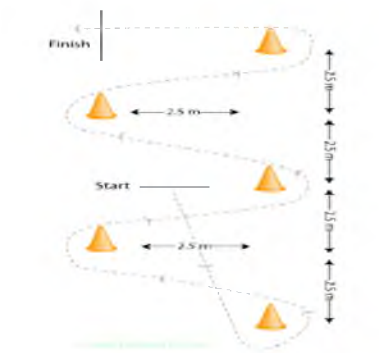

Fig. 5. AFL Agility Test
(www.topendsports.com/testing/tests.html)

Arrowhead Agility test

This test is used for testing agility and the capacity to change direction and slalom through cones.

To do the test we need: a flat surface, 5 cones and a stopwatch.

The student starts from the "start line", runs to cone "A", slaloms through cone "A" and "D" then through cone "B", then runs as fast as he can back to the start/finish line.

Program used for developing agility at the experimental group

The experimental group followed a special program for developing agility particularities like speed, speed of movement, lateral movement, running in different directions etc. They performed a two times training per week on physical education classes for 12 weeks, so they had approximatively 24 lessons that included the development of this skill. We introduced one week of recovery in the middle of the program. Training sessions for the experimental group consisted in 10 minutes of warm-up and 40 minutes of exercises indoor.

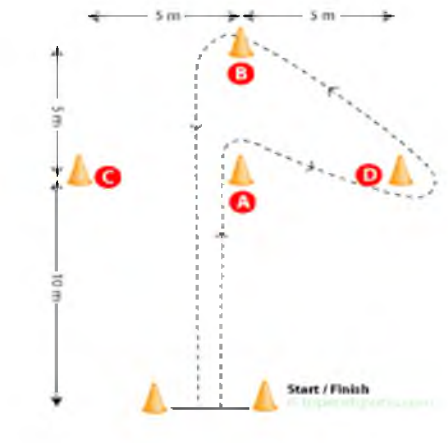

Fig. 6. Arrowhead Agility Test
(www.topendsports.com/testing/tests.html)

Table I. Training program for developing agility at the experimental group

Training session	IT	1	2	3	4	5	6	7	8	9	10	11	12	FT
Learning the special technique for agility and changing direction		x	x	x										
Frontal agility movement					x	x	X	x	x	x				
Lateral agility movement	X				x	x	X	x	x	x				X
Changing direction agility movement 90 degrees											X	x	x	
Changing direction agility movement more than 90 degrees											X	x	x	
Backward agility movement					x	x	X	x	x	x				
Other Agility tasks											X	x	x	

Legend IT – Initial test; FT – Final test

4. Results

After finishing the 12 week training program for developing the agility skills, we tested our two groups using some specific agility tests selected for analyzing the lateral movement, speed of movement, coordination, and speed, the test were: Agility T-test, Illinois Agility Test, Agility Cone Test, Box Drill Agility Test, AFL Agility Test, Arrowhead Agility Test.

The results of the tests are shown in the following tables and graphs. The test was carried out 2 times, first the Initial test at the beginning of the experiment (T1) and the second test at the end of the experiment Final test (T2). As we can see we had improvements in both groups in every test but the numbers were higher in the experimental group.

Table II. Testing agility at primary school level – experimental group

Agility Test	Mean		Standard Deviation	Standard Error	Confidence Interval for Mean	
	T1	T2			Lower Bound	Upper Bound
1. Illinois Agility	21.73	20.60	3.567	0.765	19.25	23.84
2. Agility T-Test	16.42	15.36	2.126	0.643	15.38	22.11
3. Agility Cone	10.06	9.23	2.098	0.601	9.00	13.58
4. Box Drill	14.26	12.19	3.193	0.732	12.20	18.35
5. AFL Agility	10.64	9.12	3.121	0.987	10.12	11.82
6. Arrow head	11.80	10.48	3.332	0.742	10.93	13.60

The first step in our experiment was to apply the initial tests on both the experimental and the control group, in October 2014, at the beginning of the study. Both groups had six agility tests that were performed twice and the best performance was recorded. Then the two groups worked separately, in the experimental group we had a 12 week period of trainings that had as main objectives developing the agility skills, and in the control group we had a regular PE class. After the training period, in March 2015 the pupils took the Final Tests and the results were significantly higher in the experimental group than the control group, as shown in Table 1 and Table 2. Fig. 7 and 8 present the difference in the arithmetic mean in both groups at every test. As we can see progress was recorded in both groups but mostly in the experimental group. The interpretation of the results was made with Mann-Whitney test. The initial testing of both groups obtained a p value = 0.4631 ($p<0.05$), which is statistically significant. The p value for the final test

was also statistically significant p<0.0284 (p<0.05).

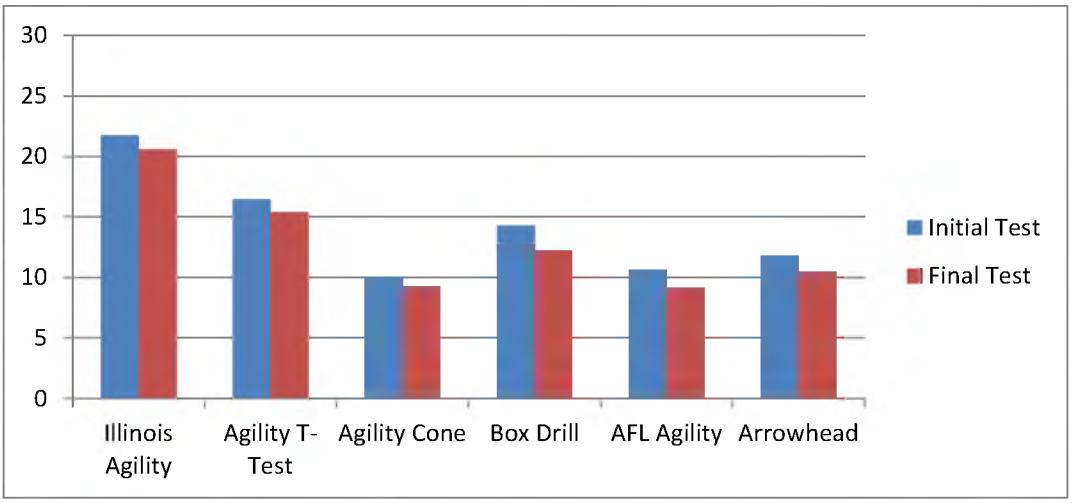

Fig. 7. Agility test at experimental group - the arithmetic mean of agility test results

Table III. Testing agility at primary school level – control group

Agility Test	Arithmetic mean		Standard Deviation	Standard Error	Confidence Interval for Mean	
	T1	T2			Lower Bound	Upper Bound
1. Illinois Agility	24.95	23.01	3.691	0.824	31.67	20.18
2. Agility T-Test	17.12	16.71	2.368	0,678	22.11	14.82
3. Agility Cone	10.25	10.04	2,237	0.657	13.58	9.20
4. Box Drill	14.03	13.79	3,232	0.798	18.35	12.20
5. AFL Agility	12.22	11.42	3,127	0.743	16.04	11.77
6. Arrow head	14.09	13.03	3,321	0.782	17.05	11.00

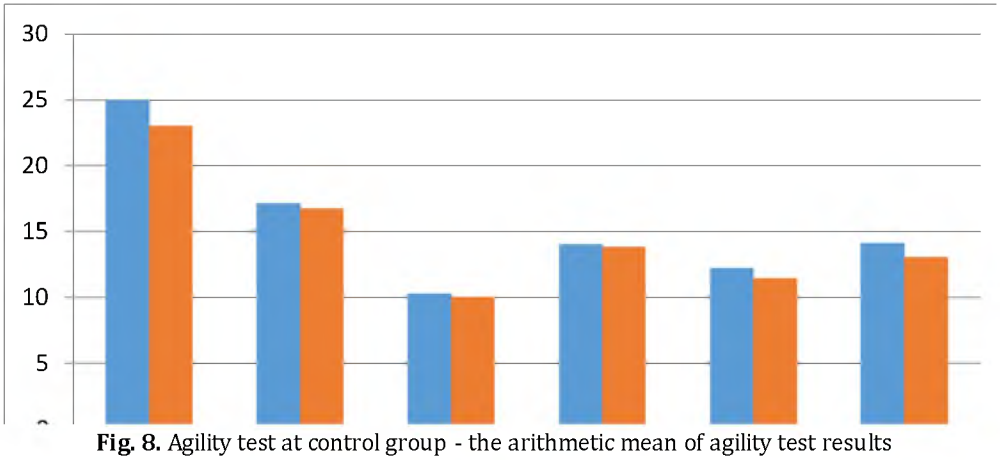

Fig. 8. Agility test at control group - the arithmetic mean of agility test results

Analyzing Table 1 – with the experimental group, we can see that progress has been made in Illinois Agility test, the mean at Initial Test was 21.73 seconds and at the Final Test it was 20.60 which indicate a progress of 1.43 seconds. At the Agility T-test performance of the experimental group during the Final Test was 15.36 comparing to the Initial Test 16.42; therefore we can state that there is a

progress of 1.08 seconds. At the agility cone test the initial performance was 10.06 seconds while the final performance was 9.23 with a progress of 0.83 seconds. Also we recorded progress of 2.07 seconds in Box Drill agility test, 1.52 seconds in AFL Agility test and 1.32 in Arrowhead Agility test, between initial and final tests. Analyzing Table 2 with the control group we can see lower progress in agility development between the moment of the initial and final tests. So as we can see we had a 1.94 seconds progress in Illinois Agility but lower performance than the mean of the experimental group (20.60); 0.41 seconds progress in Agility T-test; 0.21 seconds in Agility Cone test; in Box Drill test 0.24 seconds; 0.80 seconds in AFL Agility Test and in Arrowhead Agility test 1.06 seconds, between initial and final tests.

4. Discussions and conclusions

Some skills are very well and easily developed in young subjects, skills such as coordination, speed, moving in different directions and other components of agility. Our study focused on how important it is to develop agility skills and also on testing agility. As we can see the results showed significant improvement in both the experimental and control groups in all six agility tests. In Table 1 we can see the results in the Initial and Final tests for Agility T-test (Fig. 1), Illinois Agility Test (Fig. 2), Agility Cone Test (Fig. 3), Box Drill Agility Test (Fig. 4), AFL Agility Test (Fig. 5) and Arrowhead Agility Test (Fig. 6).

As we can see in Table 1 and Table 2, we calculated some statistical parameters such as: Arithmetic mean, Standard Deviation, Standard Error and Confidence Interval for mean (lower bond and upper bond). The arithmetic mean was calculated in both the initial and final testing to see the progress made in developing agility skills.

All test had high reliability coefficients. The results showed that the selected tests were efficient and achieved their goal. The training program for developing agility in the experimental group was a success. Moreover in very few research papers can we find agility development and testing in this age group, even if this skill is very important in the future motor and sports development of young subjects.

In comparison with other studies our study is focused on children's agility development and testing; other studies analyze for example the effect of agility training on athletic strength performance and show the importance of this skill in developing strength [35]; other studies, like the one carried out by Young, et. al. [36] discovered the specificity of the training response of agility training for 6 week program and found out that developing agility had a limited transfer in training for speed. Research papers from other scientist proved that the usage of the Agility T-test has a significant correlation with the 40 yard sprint both in men and women. Pauole, et al. [37], as well as our study show significant correlations with his research in regard to proving that developing agility can improve performance in team sports activities.

Moreover, agility training combined with the task of reaction to a specific sound signal can improve the speed of reaction also improving leg extensor strength [38].

We can conclude that training the skills that are specific for agility such as speed, speed of movement, lateral movement, and coordination has a positive effect on the movement technique [39] and on the ability to improve the efficiency of strength in lower limb muscle system [40].

In conclusion, as we can see, developing and testing skills like agility, speed and coordination can improve children's performance in physical education, agility being one of the most important skills in nowadays sports performance.

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