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STUDY REGARDING THE DEVELOPMENT OF LEG STRENGTH IN FIFTH GRADERS THROUGH PLYOMETRICS

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Abstract: *The diversity and attractiveness of plyometrics have determined the authors to verify its effectiveness in fifth graders. The working hypothesis was the following: The use of plyometrics to develop leg strength in fifth graders could contribute to an increase in both the values of this motor skill and the self-esteem of the subjects, manifested through the desire to start practicing a professional sport. The study was conducted between October 2018 and April 2019 at the "Silviu Dragomir" High School of Ilia, Hunedoara County. This study employed the following research methods: the scientific documentation, the observation, the experiment, the statistical-mathematical method, and the graphical representation method. At the end of the study, the hypothesis was validated.*

Key words: *pupils, middle school, plyometrics*

1. Introduction

The jump is a natural human motor action. It is encountered in most sports under various guises and as athletic events in themselves.

According to the Romanian Language Dictionary (1998), the jump is: *a sudden take-off of a body from its initial position and movement in a certain direction or over a distance covered as a result of such movement, or an athletic event based on this movement, or going over something, skipping the natural succession of things.*

The jump is *the result of an impulse*. *Jumping* comprises a series of drills that aim to accomplish certain tasks: forming the ability to jump as far/high as possible; educating the flight coordination and balance during simple jumps, as a start for more complex movements for the jumping events; forming and consolidating the smooth landing; developing the strength, the spring, the specific endurance (through a high number of repetitions).

Physiologically, *jumping* involving a relatively high number of beats per minute (150-170), it is used also to increase the work intensity when needed [4].

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The plyometric method is based on the principle of progression and the rule of patience [3] because the effects of this method are visible generally after a longer period of time. A few years of plyometrics training will help the athlete progress faster. Previous experience is a determining factor also in preventing injuries. For the development of the shock absorption ability, one needs to consider when and how plyometrics should be introduced. They are predominant in the track and field training, but they can be found also in the training of athletes in which the sport needs them to jump [2] [6] [7]. However, these exercises must be performed gradually and for many years. They should start around the age of 11-14.

The careful selection of the action systems and application strategies must lead to an avoidance of injuries and to the creation of premises for correct performances [1].

A significant advantage of plyometrics is that it does not need special or expensive equipment.

In fifth grade, the pupils are 11-12 years old, an age when, according to experts, the children go from childhood to puberty [5], [8].

During this period, all the body segments are developed. That is why since early stages the training must be done harmoniously, gradually and in a personalized manner.

2. Research Objectives and Hypothesis

The research aimed to study fifth graders, observing their body's reaction after performing plyometrics-based exercises during the physical education lesson. Also, the authors wanted to find out how much the plyometric exercises contribute to better performances during current assessments, and especially which ones.

Considering these aspects, **the working hypothesis** was the following:

The use of plyometrics to develop leg strength in fifth graders could contribute to an increase in both the values of this motor skill and the self-esteem of the subjects, manifested through the desire to start practicing a professional sport.

3. Tasks of the Research

The tasks of the research comprised the creation of the experimental protocol, the selection of the subjects, dividing them into the witness and experimental group, establishing the number of lessons for the development of strength, choosing the age-appropriate exercises, the application of the assessment challenges, the analysis and interpretation of the data.

The study aimed also to determine the correlation between plyometrics and the psychomotor skills. In this sense, the authors thought it was necessary to test the movement speed through the 50m sprint, the leg strength through the standing long jump, jumps on and off the gymnastics bench using both legs in 30 seconds (as markers for the motor potential) and the hip diameter (as an anthropometric measurement) in both groups, for the initial and final tests.

This study employed the following research methods: the scientific documentation, the observation, the experiment, the statistical-mathematical method with the help of the SPSS software, and the graphical representation method.

4. Place and Duration of the Research

The research was conducted at the "Silviu Dragomir" High School of Ilia, which has an outdoor athletics court, and an indoor court that has all the materials needed for the physical education lesson.

The research took place over the course of seven months: October 2018 - April 2019, of the academic year 2018-2019. The experiment was conducted as follows:

- the witness group received its physical education lessons without any special program;
- the experimental group benefited from a program composed of various types of plyometric exercises, implemented over the course of seven months, October 2018 - April 2019, 15 minutes per lesson.

5. Research Subjects

The research studied fifth graders. The pupils from grades 5th A and 5th B who had no previous health issues have formed the witness and experimental groups. 10 pupils from 5th A composed the witness group, and other 10 from 5th B formed the experimental group. Both groups were composed of an equal number of females and males (5F+5M).

6. Development of the Research

The total number of subjects participating in the study was 20, of which 10 were females. Seven tests were performed for each subject:

a) anthropometric measurements:
- height, measured in centimeters;
- chest, measured in centimeters;
- weight/body mass, measured in kilograms;
- hip perimeter, measured in centimeters (specific measurement that was necessary for this study).

b) biomotor measurements:
- standing long jump, measured in centimeters;
- 50 m sprint, with a standing start;
- jumps on and off the gymnastics bench, using both legs, for 30 seconds, measured in number of jumps (this test, together with the hip perimeter, were necessary for the conclusions of this study).

The recordings and measurements were done based on the following methodology:

The 50m sprint. The race began with a standing start and was timed from the first movement. Two tries were allowed for the 50 m sprint; they were timed by the three teachers, the recorded result being the average of the three times. The result was recorded in seconds and tenths of a second. The evaluators took into consideration the subject's best time.

Standing long jump. The subject was given two tries and the best result was taken into consideration.

Jumps on and off the gymnastics bench, using both legs, for 30 seconds, measured in number of jumps.

Anthropometric measurements

- The height was measured with the stadiometer, in the standing position, the subject being barefooted.
- The weight is a perfectible marker that can be influenced in a considerable way by external factors, among which diet, which is determined by the economic status of the family, to which the educational factors can be added. The body

weight was measured with a medicinal scale.

- The hip perimeter was measured with the measuring tape.
- Three structures of plyometric exercises were conceived for the experimental group, for the duration of the seven months.

In the months 1-3 the following exercises were used:

– Take-off using both legs on a cube (with the height of 25 cm), maintain a half-genuflection for 2 seconds, followed by a jump down, landing on both feet, and a vertical take-off - 10 repetitions;
– Side jumps, left-right, using both legs, over a rubber band stretched at a height of 25 cm - 10 repetitions;
– Jump down from a gymnastics bench, short landing on a mattress, followed by jumping on a 40 cm tall cube - 10 repetitions;

In the months 4-5 the following exercises were used:

– Jump down using both legs from the gymnastics bench, landing with a flexed ankle, knee and hip, followed by a jump over a 30 cm tall obstacle - 15 repetitions;
– Jump using both legs closer and closer on the gymnastics bench - 10 repetitions.

In the months 6-7 the following exercises were used:

- Jump using both legs on 4 mattresses (positioned on their width), between which 3 cubes were positioned (two 40 cm tall cubes and one 25 cm tall cube. The subject lands on the tall cubes and jumps over the small one); 5 repetitions.
- The same drill, except that there are two small cubes and one large cube; 5 repetitions.
- Variations of jump rope for 5 min without breaks (test, observe how many minutes the subjects can perform).

Note: all drills were performed indoors on a synthetic surface, and outdoors on the grass when the weather was favorable.

7. Results and Discussions

By using the SPSS software, the authors have determined the average of the initial and final results for each test, the standard deviation and the Pearson correlation coefficient between the thigh circumference and the sprint, the long jump and the number of jumps on and off the gymnastics bench, using both legs, for 30 seconds.

Tables 1-4 and figures 1-3 show that the experimental group subjects who used the plyometrics program have recorded a progress that is visibly higher during the final testing than the control group subjects, with the exception of jumping on the bench, where both groups have recorded a weaker result, which can be explained by the fact that in that day the pupils had to participate in a local competition. Table 1 presents the average values of the two groups regarding the anthropometric measurements.

Table 1

Average values of the anthropometric measurements following the initial and final tests- Case Summaries

Group of the subject	time of test		time of test	subject height	chest circumference	subject weight	thigh circumference
Witness group	Initial testing	N	10	10	10	10	10
		Mean	1.00	149.400	75.350	53.050	47.100
	Final testing	N	10	10	10	9	10
		Mean	2.00	150.600	76.050	52.778	49.000
Experimental group	Initial testing	N	10	10	10	10	10
		Mean	1.00	152.600	75.950	49.330	45.700
	Final testing	N	10	10	10	10	10
		Mean	2.00	154.250	77.150	51.200	49.000

Table 1 shows that the subjects' average height values were initially 149.4 cm and 150.6 cm finally for the witness group, and 152.6 cm initially and 154.2 cm finally for the experimental group. The chest circumference was 75.350 cm initially and 76.050 cm finally in the witness group, and 75.950 cm initially and 77.150 cm finally in the experimental group. The weight was 53.35 kg initially and 52.77 kg finally in the witness group, and 49.33 kg initially and 51.15 kg finally in the experimental group. The thigh circumference was 47.10 cm initially and 49.00 cm finally in the witness group, and 45.70 cm initially and 49.00 cm finally in the experimental group. The authors believe that this increase in the thigh circumference in the experimental group is due to the exercise program.

Table 2

Average values for the standing long jump during the initial and final tests

Case Summaries

group of the subject	time of test	N	Mean	Std. Error of Mean	Std. Deviation	Kurtosis	Std. Error of Kurtosis	Skew-ness	Std. Error of Skewness
Witness group	Initial testing	10	126.50	6.994	22.117	.124	1.334	-.635	.687
	Final testing	10	125.70	8.343	26.382	-.849	1.334	-.267	.687
Experimental group	Initial testing	10	153.60	5.858	18.524	-2.026	1.334	.072	.687
	Final testing	10	156.20	6.037	19.089	-1.396	1.334	.302	.687

Table 2 presents the average values for the standing long jump during the initial and final tests, recorded by both groups. In this case there is a small, insignificant regress of 0.8 cm in the control group subjects recorded during the final testing, compared to the experimental group subjects, who recorded an average progress of 2.6 cm. Graphically, the results look as follows (Figure 1):

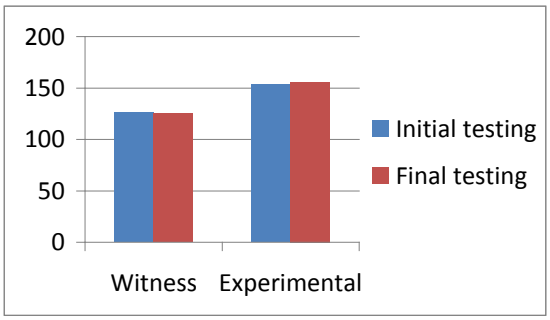

Fig. 1. *Average values for the standing long jump during the initial and final tests recorded by both groups*

Table 3 presents the average values for the sprint during the initial and final tests. In this challenge, the difference between the initial and final results was 0.03 seconds in the control group and 0.33 seconds in the experimental group.

Table 3

Average values for the sprint during the initial and final tests

Group of the subject	time of test	N	Mean	Std. Error of Mean	Std. Deviation	Kurtosis	Std. Error of Kurtosis	Skewness	Std. Error of Skewness
Witness group	Initial testing	10	8.8710	.30403	.96143	-.687	1.334	-.172	.687
	Final testing	10	8.8420	.36555	1.15597	-.322	1.334	.588	.687
Experimental group	Initial testing	10	7.8910	.28917	.91443	-1.213	1.334	.411	.687
	Final testing	10	7.5650	.25064	.79258	-.128	1.334	.398	.687

Graphically, the results are expressed as follows in Figure 2.

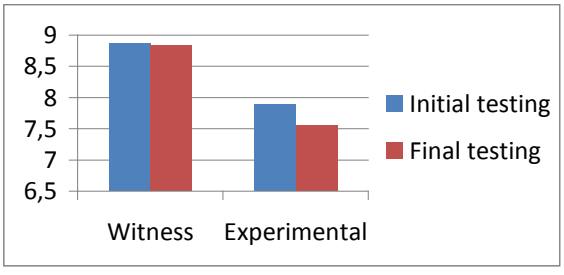

Fig. 2**.** *Average values for the sprint during the initial and final tests recorded by both groups*

Table 4 presents the average values for the gymnastics bench jumping for 30 seconds recorded by the two groups during the initial and final tests. In this challenge, both groups recorded smaller values during final test than during the initial one, which in the author's opinion, has the same explanation as in the previous case.

Table 4

Average values for the gymnastics bench jumping during the initial and final tests

Group of the subject	time of test	N	Mean	Std. Error of Mean	Std. Deviation	Kurtosis	Std. Error of Kurtosis	Skewness	Std. Error of Skewness
Witness group	**Initial testing**	10	**14.90**	2.036	6.437	-.225	1.334	-.448	.687
	Final testing	10	**14.70**	1.491	4.715	-.455	1.334	.322	.687
Experimental group	**Initial testing**	10	**21.40**	1.720	5.441	-1.160	1.334	-.262	.687
	Final testing	10	**20.10**	1.935	6.118	-1.863	1.334	.227	.687

Graphically, the results are expressed as follows (Figure 3):

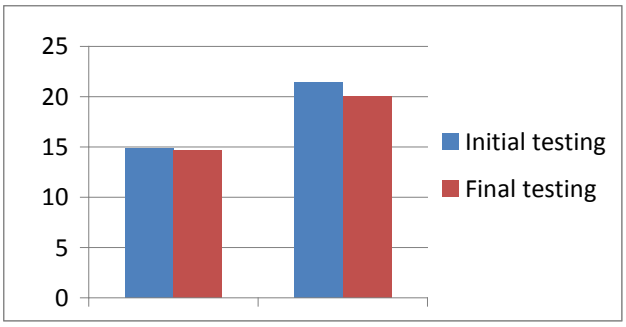

Fig. 3. *Average values for the gymnastics bench jumping during the initial and final tests recorded by both groups*

In order to verify how effective the program that was applied to the experimental group was, and whether its results were influenced by an increased muscle strength, the Pearson correlation coefficient was calculated for all the physical challenges, in relation to the thigh circumference. Table 5 presents the Pearson correlation coefficient for the thigh circumference and the long jump. In this case, the Pearson correlation coefficient has a value of -691 for the experimental group and a value of -103 for the control group, which signifies a higher closeness to -1 for the experimental group. Thus, it can be said that between the two variables there is a medium and reverse relationship.

Table 5

The Pearson correlation coefficient for the thigh circumference and the standing long jump

Descriptive Statistics

Group of the subject		Mean	Std. Deviation	N
Witness group	**thigh circumference**	**48.050**	4.3827	20
	standing long jump	**126.10**	23.697	20
Experimental group	**thigh circumference**	**47.350**	6.0374	20
	standing long jump	**154.90**	18.356	20

Correlations

Group of the subject			thigh circumference	standing long jump
Witness group	**thigh circumference**	Pearson Correlation	1	-.103
		Sig. (2-tailed)		.664
		N	20	20
	standing long jump	Pearson Correlation	-.103	1
		Sig. (2-tailed)	.664	
		N	20	20
Experimental group	**thigh circumference**	Pearson Correlation	1	-.691**
		Sig. (2-tailed)		.001
		N	20	20
	standing long jump	Pearson Correlation	-.691**	1
		Sig. (2-tailed)	.001	
		N	20	20

Table 6 presents the Pearson correlation coefficient for the thigh circumference and the 50 m sprint. In this case, the Pearson correlation coefficient has a value of -331 for the experimental group and a value of +0.469 for the control group. This indicates that the correlated phenomena are independent or tend toward independence. The relationship between the phenomena in this case is insignificant.

Table 6

The Pearson correlation coefficient for the thigh circumference and the sprint

Descriptive Statistics

Group of the subject		Mean	Std. Deviation	N
Witness group	**thigh circumference**	**48,050**	4.3827	20
	Sprint	**8.8565**	1.03491	20
Experimental group	**thigh circumference**	**47.350**	6.0374	20
	Sprint	**7.7280**	.84948	20

Correlations

Group of the subject			thigh circumference	Sprint
Witness group	**thigh circumference**	Pearson Correlation	1	.019
		Sig. (1-tailed)		.469
		N	20	20
	Sprint	Pearson Correlation	.019	1
		Sig. (1-tailed)	.469	
		N	20	20
Experimental group	**thigh circumference**	Pearson Correlation	1	-.339
		Sig. (1-tailed)		.072
		N	20	20
	Sprint	Pearson Correlation	-.339	1
		Sig. (1-tailed)	.072	
		N	20	20

In table 7, the Pearson correlation coefficient for the experimental group is the closest to -1, thus the relationship between the two variables is very strong and reversed. The experimental group records a Pearson coefficient of -0.845, while the control group, of -516.

Table 7

The Pearson correlation coefficient for the thigh circumference and the gymnastics bench jumping for 30 seconds

Descriptive Statistics

Group of the subject		Mean	Std. Deviation	N
Witness group	thigh circumference	**48.050**	4.3827	20
	gymnastics bench jumps	**14.80**	5.493	20
Experimental group	thigh circumference	**47.350**	6.0374	20
	gymnastics bench jumps	**20.75**	5.674	20

Correlations

Group of the subject			thigh circumference	gymnastics bench jumps
Witness group	thigh circumference	Pearson Correlation	1	-.516*
		Sig. (2-tailed)		.020
		N	20	20
	gymnastics bench jumps	Pearson Correlation	-.516*	1
		Sig. (2-tailed)	.020	
		N	20	20
Experimental group	thigh circumference	Pearson Correlation	1	-.845**
		Sig. (2-tailed)		.000

Correlations

Group of the subject			thigh circumference	gymnastics bench jumps
gymnastics bench jumps		N	20	20
		Pearson Correlation	-.845**	1
		Sig. (2-tailed)	.000	
		N	20	20

8. Conclusions

Although the plyometric exercises are mostly used during their training by track and field athletes/ hurdlers/ jumpers, the effect of these exercises on the physical development can be just as beneficial in the case of 11-year old children, if the exercises are selected and performed under conditions that are adapted to the children's particularities. This study does not pretend to have had a major impact on the subjects' physical development, but taking into account the short time they were exposed to these exercises, the effects were visible, even though the experiment only lasted 7 months. The observations made on the experimental group subjects indicated that at the end of the study they managed to perform the movements more easily, with more confidence and efficiency.

Also, 5 subjects in the experimental group have expressed their intention to become professional athletes (2 in track and field and 3 in handball), which confirmed the initial hypothesis, in the sense that self-confidence increases with the strength-speed markers.

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