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STUDY ON THE DEVELOPMENT OF EXPLOSIVE FORCE IN ATHLETIC JUMPING THROUGH PLYOMETRICS EXERCISES AT THE LEVEL OF JUNIOR ATHLETES

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Abstract: *The purpose of this article is to demonstrate the importance of implementing plyometric exercises especially in the case of students in vocational mainstream education for improving relaxation and implicitly sports performance. The present paper highlights a study based on a theoretical and practical approach to the notion of plyometric by applying a specific program based on plyometric exercises for the development of explosive force in advanced groups, compared to subjects carrying out a regular training program. By implementing this type of exercise at the level of all students, regardless of the way in which they practice athletics, benefits are brought both in terms of sports performance and health.*

Key words: *athletics, plyometric exercise, explosive strength, sports performance.*

1. Introduction

Athletic jumping occupies a very important place both in physical education lessons and in sports training. The high level and degree of complexity of national athletic competitions require a standardized training, in which the originality of methods and means of work favours obtaining high performances.

Plyometric training is widely used by specialists to improve athletic performance in a wide variety of sports [8].

Plyometric exercises are widely used by athletics specialists in various phases of sports training [2], [11].

Plyometric exercises are recognized by specialists as the most suitable means of combining strength with speed to achieve the "power" needed in jumping and sprinting athletic events [3]. The popularity and appeal of these exercises has increased among students and performance athletes thanks to current international trends in the use of explosive force.

To increase the potential of future performances, it is important to apply plyometric training from an early age. Among other things, research indicates that this type of exercise has a particularly

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beneficial effect on the health and development of students (middle school and high school), regardless of the regime in which they practice sports (performance, mass education, etc. [5].

2. Plyometrics - Method of Explosive Force Development

The etymology of the term plyometrics comes from the Greek language, where "pleion" translates as "more" and "metrikos" which means "to measure" [1].

The study of the plyometric method comes to the attention of researchers in the early 1960s when the Russian school implements plyometric programs in the training of high jumper athletes [12].

The method was quickly picked up by other athletes who perfected it through numerous studies and methodologies [1].

2.1. The peculiarities of the plyometric regimen

Plyometric muscle activity involves motor actions performed by jumping. Whether they are done on one or two legs, in the kicking phase, the athlete's body lowers it's the center of gravity, directing its speed towards the ground, thus creating the damping phase or the shock absorption phase. Thus, this phase is shorter, the stronger the concentric muscle contraction [7].

Exercises with jumps and jumps are of particular importance in plyometric training, as they determine a much more efficient and ergonomic release. In other words, relaxation is improved, the value of which is already well known.

Verkhoshansky, Y. classifies plyometric training into two categories [12]:

1. *Maximum plyometric training*, where the depth jump intensity is high and the number of repetitions is low.

2.*Submaximal plyometric training*, where contact with the ground is longer and the number of repetitions is higher.

Respecting the principles of sports training and the particularities of the age of athletes, the choice of working methods is a continuous concern for those involved in sports performance.

2.2. The laws of sports training through the plyometric method

First, we focus on the athlete's background and experience in the field. If he has well-structured and applied strength training over several years, the potential plyometric performance can be significantly increased.

The athlete's previous strength experience is very valuable, as it gives them good motor skills, endurance and efficiency.

Plyometric training is a complex one, which requires a good coordination and correlation of the motor qualities of the individual. If they are already formed, as I mentioned before, it will only be up to the plyometric coach to combine them and perfect the strength-speed complex.

However, strengthening in plyometrics is a long process that requires a lot of patience, both on the part of the athlete and the coach.

Second, we consider the individual's psychological profile. As mentioned above, patience is crucial.

This can also be trained in certain ways, such as understanding the entire course of the training and its potential results.

In other words, the principles and laws of the plyometric method must be explained to the athlete in a synthetic and understandable manner. The individual needs to be aware of both the importance of a consistent approach to this training regime and the special performances he can access in this way.

Psychological counselling plays an important role in maintaining the athlete's motivation and perseverance. Psychologists specialized in sports performance resort to specific counselling methods, managing to maintain the psycho-emotional condition of the athlete [4].

Plyometric exercises should be introduced gradually from the age of 14. However, a recent study indicates that the application of plyometric training at the level of puberty (10-14 years) leads to a significant increase in performance in sporting events that require explosive strength, without putting the children at any kind of risk [3].

Research suggests practicing 50-60 plyometric jumps twice a week for 8-10 weeks [6]. After this initiation period, which period can extend even up to 2 years, the training intensity can be increased, taking into account the needs and ability of the athlete.

From here we deduce another law of plyometric exercise, otherwise universally valid in the world of sports, namely the careful monitoring of the athlete. The volume and intensity of plyometric training must be adapted by the teacher to the requirements imposed by the individual's condition.

Another notion that we can fit into the laws of plyometric training is the number of repetitions. It varies according to the intensity of the exercise and the requirements of the trainer [3].

Finally, we mention a particularly important aspect in sports training through the plyometric method, namely fatigue, specifically its anticipation, prevention and management. To begin with, it should be known that fatigue has two main compartments, i.e. local fatigue and nervous system fatigue.

1. Local fatigue implies the exhaustion of the reserves of molecules with macroergic bonds (adenosine triphosphate and phos-phorcreatine). Muscle contraction requires energy. ATP is hydrolyzed to release the energy stored in the bond between the second and third phosphate groups. This is how the ADP (adenosine diphosphate) molecule appears, which must be phophory-lated at the level of the mitochondrion in order to be restored to ATP.

This process requires nutrients, especially acid and molecular oxygen. When local fatigue occurs, anaerobic cellular respiration sets in, which produces very small amounts of ATP and a lot of lactic acid, a negative action on muscle fibres.

Stopping the exercise is necessary, so that aerobic respiration can be resumed and the reserve of ATP and CP restored.

2. Nervous system fatigue – fatigue of synaptic transmission, caused by the depletion of neurotransmitter stores in the button endings of axons.

The main chemical mediator (neurotransmitter) at the level of the neuromuscular junction is acetylcholine. When adequate amounts of neurotransmitter are not present, the postsynaptic cell is not properly stimulated, the nerve impulse being diminished from “synapse-to-synapse”.

If the stimulus on the muscle fiber is not strong enough, the Ca2+ channels (an element with a fundamental role in muscle contraction) at the level of the sarcoplasmic reticulum do not open/partially open, and calcium will not reach the myofibrils in adequate quantities or even at all [3], [9,10].

Fatigue is followed by exhaustion, a condition of the athlete that leads to injury and injury. That is why the effective management and anticipation of fatigue is an important law of plyometric training.

3. Material and Methods

The research was carried out between October 2022 and March 2023 at the High School with Sports Program Brasov (HSSPBV), athletic department.

The study included three stages:

1. Initial Testing (IT) between October 1 and 6, 2022
2. Conducting the research by applying the independent variable to the experiment group
3. Final testing (TF) between March 20 and 25, 2023.

The study was carried out on 2 groups of athletes:

1. *Experimental group* – eight athletes from the advanced group of LPSBV.
2. *Control group* – eight athletes from the advanced group of HSSPBV.

The period of the experiment extended over approximately 5 months, starting in October and ending in March, when the sports competitions began. In this time interval, the independent variable was applied to the experimental group, made up of carefully selected and adapted means of action specific to athletics.

The independent variable, consisting of plyometric means specific to athletics, was applied to the experimental group during the research period.

3.1. The procedure for carrying out the research

The research included three main stages:

1. *The ascertaining stage*, in which the training level of the subjects is established by applying the tests and specific tests for the assessment of the biomotor capacities. The initial testing gives a clear vision of the existing training baggage, a fact that allows the following training to be customized, depending on the case, so the work plan can be developed as efficiently as possible.

2. *The experimental stage* represents the longest period of the research, because the targeted results do not appear immediately. This involves applying the training models after leveling the study samples. The experimental group will be acted upon with the plyometric exercise program with the aim of significantly increasing indices of explosive strength.

3. *The verification stage* is the one in which we ascertain the final results in various ways, such as the verification tests, or through the results obtained in certain competitions, which are ultimately the object of the applied training. The differences between the two groups will be analyzed from a mathematical point of view, thus ascertaining the level of the students. The conclusions established after this stage will confirm or not the veracity of the hypothesis presented at the beginning of the paper.

3.2. Specialized training model

Objectives:

- improving physical development
- general
- strengthening the technique of running with acceleration/step launched;

- development of general strength;
- development of explosive strength with light plyometric exercises;
- consolidating/perfecting the technique
- long jump with elk;
- theoretical training related to plyometric methods.

• The preparatory part:
- easy run 1000 m
- joint mobility 10 min
- special exercises 2 x 40 m
- sprint run 4 x 60 m, I 75%

•The fundamental part
- accelerated running 5 x 30 m
- alternating jumping rope (S-D) 6 x 30, I 75%, P 2 min
- jumps over small hoops 40 cm 2 x 5 x 20m, I 80%, P 4 min
- alternative gymnastic bench jumps (S-D) 5 x 20
- counter jumps 40 cm 5 x 20, I 80%, P 4 min
- standing long jump 5 x 20, I 75%, P 2 min

• The closing part:
- joint mobility 20 min;
- easy run 1000 m

4. Results and Discussions

4.1. Research-specific evidence

a) Long jump without momentum
b) The Sargent Jump test - the detent on vertically

a) Long jump without momentum

Table 1

Long jump results without momentum and correlated values in the experimental group

Experimental group	Ti (m)	Tf (m)	Δd (m)
S1	2,20	2,45	0,25
S2	2,00	2,18	0,18
S3	2,15	2,35	0,20
S4	2,25	2,45	0,20
S5	2,05	2,20	0,15
S6	2,35	2,55	0,20
S7	2,40	2,60	0,20
S8	2,38	2,55	0,17
Arithmetic mean $\bar{X}$ (m)	2,22	2,42	0,19
Standard deviation – S	0,14	0,15	0,02
The coefficient of variability - CV	6,30%	6,19%	10,52%
Amplitude – W (m)	0,40	0,42	0,1

Table 2

Long jump results without momentum and correlated values in the control group

Control group	Ti (m)	Tf (m)	Δd (m)
M1	2,05	2,08	0,03
M2	2,15	2,20	0,05
M3	2,00	2,05	0,05
M4	2,10	2,13	0,03
M5	2,05	2,09	0,04
M6	2,10	2,12	0,02

Control group	Ti (m)	Tf (m)	Δd (m)
M7	2,12	2,15	0,03
M8	2,16	2,20	0,04
Arithmetic mean $\bar{X}$ (m)	2,09	2,12	0,03
Standard deviation – S	0,05	0,06	0,01
The coefficient of variability - CV	2,39%	2,83%	33,33%
Amplitude – W (m)	0,16	0,15	0,03

b) Sargent Jump Test

Table 3

The Sargent Jump test results and correlated values in the experimental group

Experimental group	Ti (m)	Tf (m)	Δd (m)
S1	58	66	8
S2	55	65	10
S3	59	65	6
S4	62	68	6
S5	60	74	14
S6	67	78	11
S7	65	79	14
S8	69	83	14
Arithmetic mean $\bar{X}$ (m)	61,87	72,25	10,37
Standard deviation – S	4,48	6,7	3,23
The coefficient of variability - CV	7,24%	9,27%	31,14%
Amplitude – W (m)	14	18	8

Table 4

Sargent Jump Test Results and Correlated Values in the Control Group

Control group	Ti (m)	Tf (m)	Δd (m)
M1	53	57	4
M2	52	58	6
M3	61	64	3
M4	59	67	8
M5	65	72	7
M6	64	69	5
M7	63	70	7
M8	67	73	6
Arithmetic mean $\bar{X}$ (m)	60,5	66,25	5,75
Standard deviation – S	5,14	5,69	1,56
The coefficient of variability - CV	8,49%	8,58%	27,13%
Amplitude – W (m)	15	16	4

a) The long jump without momentum is an event that relies solely on the explosive force required to lift off the ground.

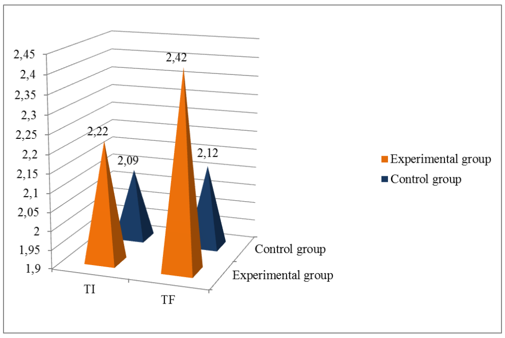

Fig. 1. *Graphical interpretation of the long jump results without momentum for the two groups*

If we follow figure 1 that centralizes the averages of the two groups over time, we notice that the experimental sample enjoys much higher performances (from 2.2 m to 2.4 m), while the average TF and TI of the control group is almost identical. This is due to plyometric training, the purpose of which is to increase the relaxation of the athletes.

When analyzing the coefficient of variability, we realize that, for the experimental group, it is decreasing at the final moment compared to the initial one, showing the appearance of homogeneity at the collective level. This phenomenon testifies to the fact that, over time, the applied training raised all subjects to approximately the same level. The rest of the numerical differences are small.

When we study the CV values in the control sample we notice a visible increase (from 2.4% to 2.8%). Although the difference is not dramatic, it is understood that the applied classical training causes a slight increase in intracollective heterogeneity.

If we correlate the values recorded in this trial with those from the height, we find the following: Although DE, who is at the final moment the tallest (189.5 cm), he does not register by far the best performance in the jump. On the contrary, the record is held by CL (185 cm) at that time, a fact that proves that somatic privileges are not the defining factors in achieving performance.

b) Taking into account both the values recorded at the level of the two samples of subjects and the values of the related relaxation and qualification of the Sargent Jump test, we can classify the average result of the experimental group from the qualification "excellent", which attests to the increased effectiveness of the plyometric training method that was applied.

We also track the discrepancies between the two groups in terms of evolution over time. Although neither stagnates, the mean at TF of the experimental sample is noticeably higher than that of the control group, figure 2.

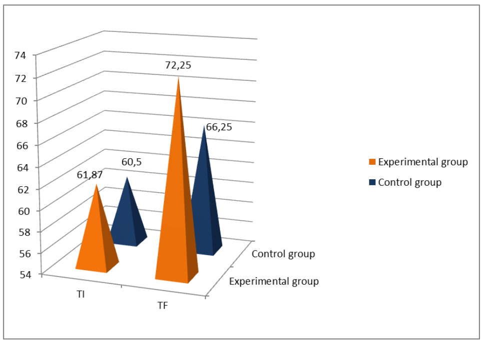

Fig. 2. *Graphical interpretation of Sargent Jump test results for the two groups*

The coefficient of variability of the collected values is, in both cases, at the optimal parameters, indicating a good homogeneity of the groups. At the Δ section, it shows increased values, which suggest a varied evolution of the measured values and confirm the diversity of the changes that occurred in order to obtain increased and relatively homogeneous results.

The graphic representation of these statistical values highlights the differences between the two applied training methods, confirming again the special effect of the plyometric exercises.

3. Conclusions

All systematized theoretical notions, recorded results and outlined statistics confirm the implementation of plyometric exercises for the development of explosive force in junior athletes.

The results obtained in the research tests are superior in the case of the experimental group, a fact that attests to the importance and special effectiveness of plyometric training.

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