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Plyometric Training And Its Effects On Power And Speed, Applying A Program Of Plyometric Intervention In Pre-Pubertal Children Practicing Indoor Soccer

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Abstract

The study aims to determine the effect of strength training from the plyometric method on power and speed, applying an intervention program in prepubertal children practicing indoor soccer. The selected sample was divided into two groups: control (group that continued with the development of the basic training established by the sports training school) and experimental (group to which was applied, in addition to the training activities of the sports training school, the intervention program). In the development of this research, the quantitative approach was taken into account, allowing making conjectures in the research process to generate descriptive and correlational scopes between the control and experimental groups. The intervention was developed establishing ten weeks for the execution of the program, with a training frequency of three weekly sessions. Three blocks were established: block one, self-loading; block two, elastics; and block three, traction and facilitated exercises. The following tests were used for the evaluation: University and Illinois agility tests, thirty-meter speed, Abalakov, CMJ counter-movement jump, squat jump, as well as the percentage of muscular contraction and the percentage of elastic contribution.

Keywords: Plyometric Training, Physical Education, Pre-Pubertal Children.

1. Introduction

The scientific community related to health processes, as well as development and application of sports training has already managed to unify clear criteria on the process of strength training in pre-pubertal youth. These international agreements have as a premise that the intervention of strength work in young people must be supervised to ensure validity, safety and effectiveness in order to achieve better health and outstanding physical performance processes in the participants, all this from the first pronouncement as referenced by Lloyd et al. (2016).

There are those who support them, but there are also those who refuse to apply them, because the approach to strength in pre-pubertal ages requires those responsible to appropriate clearly what is intended and understand what level of development is to be reached. Respecting the biological processes of each stage of life, by using plyometrics as a means for development, it is intended to provide valuable tools to develop power and speed approached from the work with self-loads. Of course, the biological age and chronological age should be factors to consider, and the motor and training experience should also be considered. It can also be assured that a minimum chronological age is not strictly enforced to start strength training. It is enough for young people to demonstrate competent skills in terms of balance and a solid base of postural control that are necessary for plyometric work. It should be emphasized that pre-puberts must show an acceptable maturity in terms of their emotions and psychological maturity to allow them to understand and assimilate the instructions and explanations given by the person who accompanies and supervises the application of the training plans (Behm et al., 2008; Klentrou, 2008).

The application of pre-tests will facilitate the initial measurements and give an introductory look at the state of the trainees involved in the research study, providing the necessary data for the design and structure of a strength training program based on the plyometric model, which seeks to establish the effects of strength training from the plyometric method on power and speed. The application of the program does not address all the components that integrate a training plan, so, only the experimental group will be contacted during the central part of the training session, with intervention in 10 weeks of the general preparation period, divided in three blocks. Once this stage is completed and the pots-tests are applied, the impact of the intervention program will be assessed based on plyometric exercises on power and speed in pre-pubertal children.

It is important to make clear that this intervention program may allow achievements, but at no time is intended to reach high performance. For this reason, there are two groups to advance the application, a control group and an experimental group trained at the same time but with differentiated work. The control group will follow the routine of their own training and the experimental group will be subject to the application of specific exercises of this study, and only during the central part of each scheduled session. In this sense, in the intervention plan proposed by the researcher, he proposed 3 blocks of work looking for the development of strength, generating a self-loading block, with 9 sessions and 7 exercises; a second elastic block, with 9 sessions and 4 exercises and a third block of traction and facilitated exercises, with 12 sessions and 5 exercises.

Likewise, this research work addresses the strength training supported by the plyometric method, understanding plyometry as a muscular activity in which the movements are framed within the cycle of stretching and shortening within which activities or exercises are developed such as; throws, jumps in different contexts, rebounds, with which it is intended to meet the requirements of the sport discipline and facilitating the safe development of biological elements that can be used in their actions as an athlete.

2. Objectives

2.1 General Objective

To characterize the effects of strength training from the plyometric method on power and speed in pre-pubertal children practicing indoor soccer.

2.2 Specific objectives

- To determine the level of power and speed of pre-pubertal children.
- To design the training program defined plyometric method in pre-pubertal children.
- Development and application of the plyometric training program in pre-pubertal children.
- To establish the effects of strength training under the plyometric method on power and speed in pre-pubertal children.

3. Methodology

3.1 Methodological approach

3.1.1 Quantitative Approach

Recognizing that the quantitative methodological approach studies the association or relationship between quantified variables, seeking to determine the strength of association or correlation between variables, perhaps seeking to generalize the results through a sample that produces “solid and repeatable” data, the quantitative approach is used to address scenarios where what matters is to find trends and continuities with respect to a certain topic, in the case of this research, it manages to know the effects of a plyometric intervention program in pre-puberty.

By resorting to the quantitative approach, its application should allow to make conjectures in the research process to generate descriptive and correlational scopes between the groups cited to develop the intervention, which account for the objectives of this study. Under this approach, the study seeks to respond to the effects that arise in pre-pubertal population that undergoes a plyometric intervention plan being consistent with the objectives set out in it.

3.2 Methodological design

Quasi-experimental research

This type of research was devised with the purpose of determining, as reliably as possible, cause-effect relationships, for which one or more groups, called experimental, are exposed to experimental stimuli and the resulting behaviors are compared with the behaviors of that or other groups, called control, which do not receive the experimental treatment or stimulus (Tamayo, 1999).

It is clear that the current research was conducted as a quantitative study and that the quasi-experimental design applying pretest, test and post-tests, with an explanatory methodological approach to seek to explain the variables, compare their effect and measure the differences between the groups under study over a period of time, is analyzed by means of descriptive statistics performing the corresponding analyses based on the tests that were applied.

According to Tamayo (1999) there are some characteristics of quasi-experimental research, these are: a) It requires a rigorous manipulation of the experimental variables or factors, and the direct control, or by random statistical procedures, of other factors that may affect the experiment. These random procedures include the selection of subjects, the random assignment of subjects to experimental and control groups, and the random assignment of the experimental treatment to one of the groups; external factors have no control as the variables selected for the study.

Employ a control group to compare the results obtained in the experimental group, bearing in mind that, for the purposes of the experiment, both groups should be equal, except that one receives treatment (the causal factor) and the other does not.

Quasi-experimental research is the most suitable procedure for investigating cause-effect relationships because it has the advantage of being non-artificial and non-restrictive, thus allowing its application to human beings, since the requirements or controls are not as rigorous. So, according to the characteristics of this project, this type of research is more appropriate to be implemented.

3.3 Population and sample

3.3.1 Population

The population under investigation are the pre-pubescent members of the U12 category, of the Fortaleza Sports Training School, in the municipality of Malaga, Santander. Children who are stratified in levels I, II and III of the SISBEN, all regular students of the national public educational system, with domicile in the municipality of Malaga.

3.3.2 Sample

Sampling

The R Project for Statistical Computing software was used to verify whether or not the data corresponding to the prerequisite performance test come from a normal distribution and to determine the experimental and control groups randomly. Applying Shapiro-Wilk shows that the p-value is less than 0.05. that is, that the sample does not come from a normal distribution; however, the experimental and control groups were determined using the generation of random numbers without replacement.

Inclusion criteria

- Fill out the registration form as an athlete of the sports training school strength of the city of Malaga.
- Present a photocopy of the accident insurance required by the school.
- Present a card that accredits him/her as an active athlete of the sports training school fortaleza Malaga.
- Be between 10 and 12 years old.

Exclusion criteria

- Medical or surgical history that prevented him/her from performing any type of regular physical activity.
- Failure to attend the pretest or posttest.
- Failure to attend two work sessions scheduled in the intervention program.

3.3.3 Informed consent

The process of socialization and delivery of the informed consents to the parents of the children athletes was advanced for their respective knowledge and signature. Making clear the type of intervention to be carried out, the elements to be used and the oriented training processes, and the express request for the use of images only for specific purposes as evidence of this study.

3.3.4 Materials and procedures

Test:

For the development of the study, some tests will be developed to facilitate the collection of information on the functional performance status of the children subjected to stimulation, these tests are:

Speed test

Speed is a determining variable in the performance of indoor soccer, so, in order to have greater precision in the measurement of time, this test will be recorded by digital videography for subsequent computer analysis. For this purpose, a straight line of 30 meters was established, demarcating its end and beginning with white lines and cones on the ground. In addition to this, the greater trochanter of the femur of the evaluated person was marked. A Sony Handy Cam (60 Hz) camera was positioned in the sagittal plane. At the start of the test, the patient was placed at the starting line, and with the command “ready, go!” the patient tried to cover the distance in the shortest possible time. For the recording of the time, it was taken into account that the mark of the trochanter had to pass the start mark to start the time and the end mark to finish the time (Martinez Lopez, 2002).

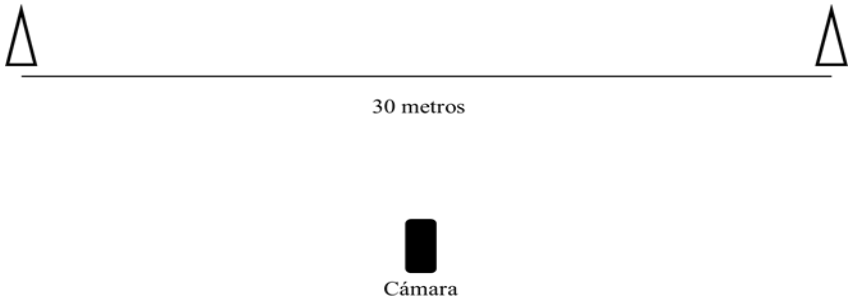

Figure 1. Distribution of 30-meter speed test.

Abalakov test

The Abalakov jump or Abalakov test (ABK) was devised by this Russian scientist in 1938 with the aim of improving the possible deficiencies of the Seargent test (1921). The measurement of the jumped height was made based on a metric strap fixed at the waist at one end (possible location of the center of mass) and free at the other end where a marker or manual meter of the jumped height is placed. The test is performed from the erect bipodal position, flexing and jumping with the help of the arms.

The specific objective of this test is to measure the ability to acquire the maximum vertical distance traveled (jump in a single area) by the body using all possible segmental movements without impulsion limitations (Free Jump). The only restriction would be that the elevation is made with the maximum possible extension of the lower limbs and that the initial contact of the fall should be made with a flexion of not less than 70° at the knee. All this to avoid maneuvers that affect the precision levels of the measurement (Martínez López, 2002).

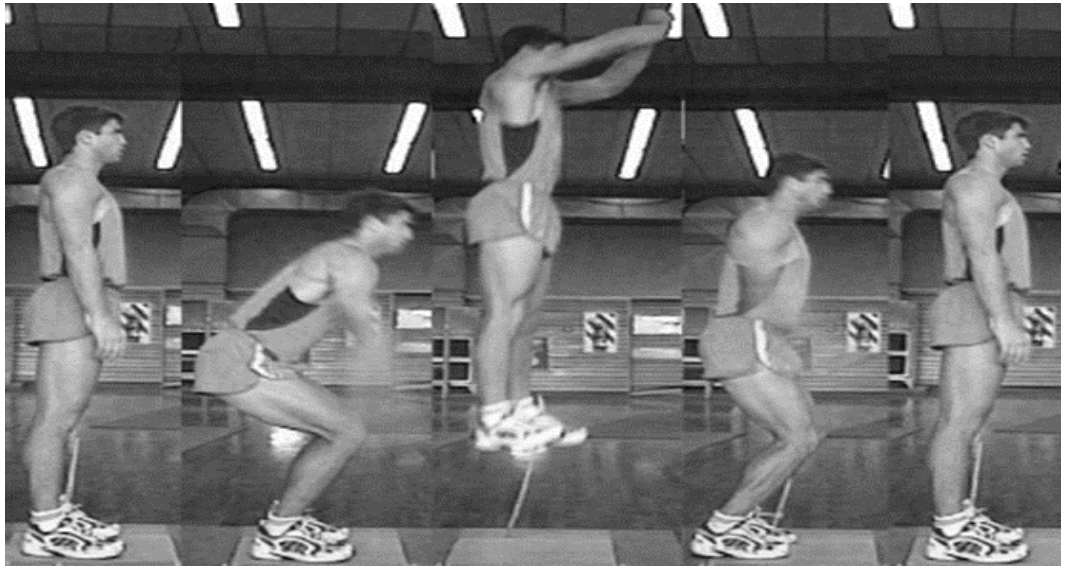

Figure 2. Abalakov x C. jump.

Squat jump test (Squat Jump)

The Squat Jump test (SJ-SC) is a restricted jump of positive concentric muscle work (reactive capacity). The subject is placed on the mat or contact mat with hands on hips or lower waist and legs flexed at knee level at a 90° inter-segmental (thigh-leg) angle. After holding the position for 5" to eliminate most of the elastic energy accumulated during the flexion, the subject performs a vertical jump as high as possible avoiding any counter-movement and without letting go of the hands, falling in the same position of the feet and legs as extended as possible (see illustration 3). Luttanen and Komi, (1979) found that the arms help 10% in the jump, and according to Bosco (1994), this test can determine the explosive strength of the lower limbs, the capacity of nerve recruitment and expresses the percentage of fast fibers FT (Fast Twich). It is used to know the reactive capacity by the difference with the CMJ- SC.

In the opinion of some authors, the technique of this exercise is quite complicated since it is almost never done without a small counter movement, which implies that a learning period must be given to strengthen the explosive coordination of the legs (Martínez López, 2002).

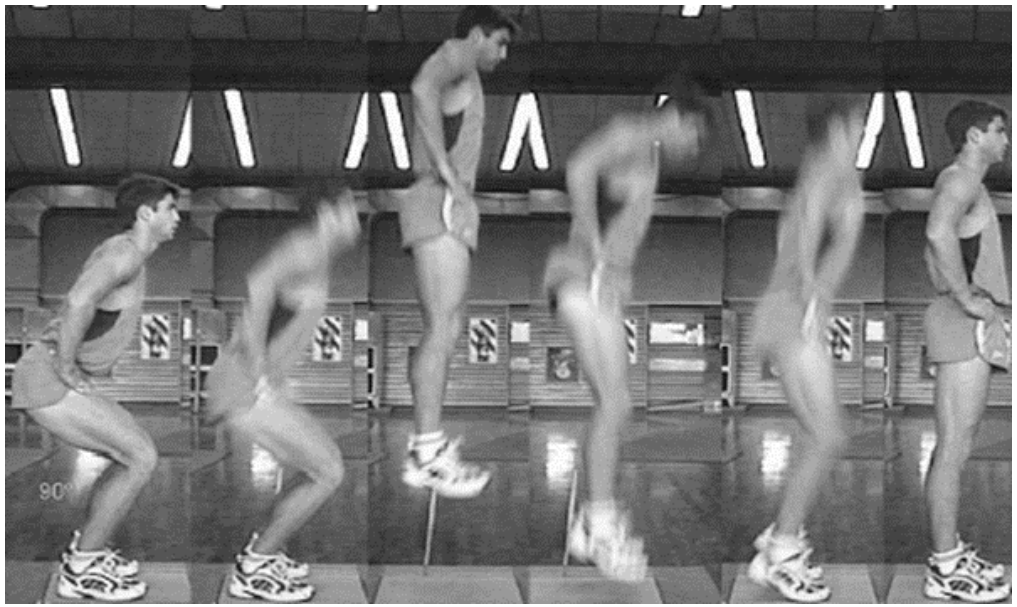

Figure 3. Jump from squat without load (SJ-SC).

Countermovement jump test (CMJ)

The countermovement jump (CMJ- SC) is a restricted jump. It is a test similar to the previous one but in which the starting position varies, which is performed with the hands on the lower waist (bi-iliocrestal line). The person starts from a vertical position, without previously bending the knees from which he/she flexes (lowering of the Body Center of Mass, CMM, or counter-movement to the final direction of the jump) and extends the legs at a high speed of execution (see illustration 4). The purpose of this movement is to use the elastic energy that accumulates in the quadriceps at the moment of flexing the legs. The quality object of the measurement of this jump has to do with the explosive strength of the lower limbs, capacity of nervous recruitment, expression of % of FT, reuse of the elastic energy and intra and intermuscular coordination. The work done is concentric preceded by eccentric activity (Counter-movement). It is used to know the difference with the ABK x C and to know the % utilization of the arms (Martínez López, 2002).

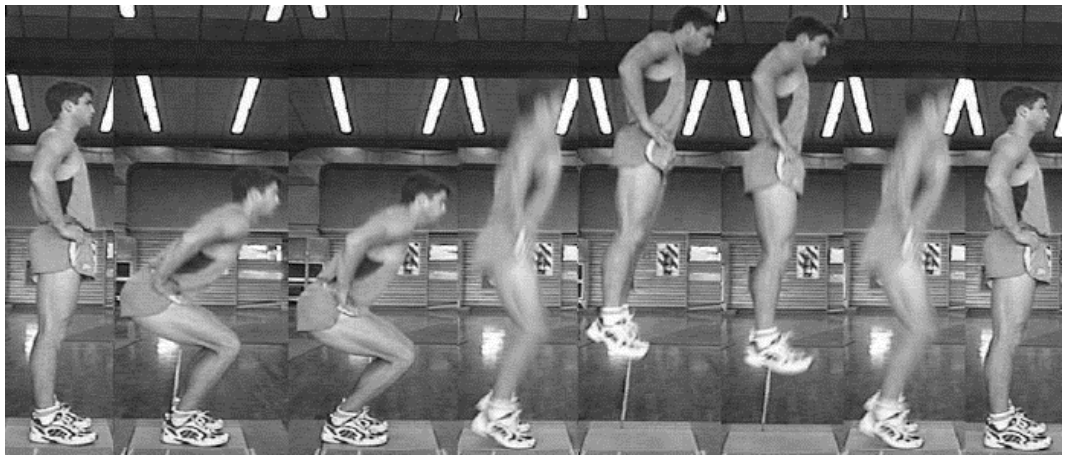

Figure 4. Jumping with counter-movement (CMJ).

4. Results

Initially, a T-test was applied to determine the status of the demographic input variables (age, level of education, educational level (see appendix 2) and thus establish the degree of similarity or difference of the subjects, as a starting point for the development of the analyses and discussions. After verifying the normality of the data (p=0.23), a two-way ANOVA test was applied (group x time), with repeated measures for each time to establish whether there are statistically significant differences between the control group and the experimental group, for which the significance level was set at 5%.

Next, the analysis of the results by variables obtained after the statistical analysis described above will be developed. Each variable will be described starting with the descriptive values and ending with the significance values in the relationship of the factors analyzed (group x moment).

Demographic characterization data of the population

Table 1. Characterization data of the experimental group.

EXPERIMENTAL GROUP				
NO.	**NAME**	**Age (years)**	**Mass (Kg)**	**STATURE (m)**
1	Subject 1	11.55	46.2	1.49
	Subject 2	12.58	48.4	1.5
	Subject 3	12.33	44.5	1.45
	Subject 4	11.50	41.3	1.4
5	Subject 5	12.75	39.7	1.49
	Subject 6	12.50	43.9	1.54
	Subject 7	11.68	46.1	1.5
	Subject 8	11.82	45.7	1.44
	Subject 9	12.17	47.5	1.54
	Subject 10	12.33	44.8	1.44
	Subject 11	11.72	45.2	1.56
	Subject 12	12.42	44.6	1.51
	Subject 13	12.17	41.2	1.49
	Subject 14	12.08	40.9	1.52
	Subject 15	12.25	47.4	1.45
	Subject 16	11.33	40.6	1.5
	Subject 17	11.17	45.5	1.52
	Subject 18	12.83	45.8	1.52
AVERAGE		12.07	44.41	1.49
STANDARD DEVIATION		0.490762453	2.604627606	0.041664706

Source: Own elaboration.

Table 2. Characterization data of the control group.

CONTROL GROUP				
NO.	**NAME**	**Age (years)**	**Mass (Kg)**	**STATURE (m)**
1	Subject 1	12.08	45.3	1.45
	Subject 2	12.03	45.7	1.46
	Subject 3	12.06	44.2	1.43
	Subject 4	11.58	41.8	1.43
5	Subject 5	11.88	44.4	1.43
	Subject 6	11.75	44.9	1.47
	Subject 7	11.50	46.5	1.43
	Subject 8	12.04	45.6	1.48
	Subject 9	11.83	46.2	1.49
	Subject 10	12.67	46.8	1.49
	Subject 11	11.58	46.6	1.47
	Subject 12	12.17	45.4	1.46
	Subject 13	11.75	41.6	1.49
	Subject 14	11.98	42.3	1.46
	Subject 15	11.92	43.7	1.47
	Subject 16	11.83	44.2	1.53
	Subject 17	11.75	44.5	1.5
	Subject 18	12.58	41.7	1.47
AVERAGE		11.9	44.52	1.47
STANDARD DEVIATION		0.30996287	1.71586218	0.02739806

Source: Own elaboration.

The initial data generated by the T-test show that the groups do not present significant differences at the beginning, a fact that facilitates the argumentation of the results, since this implies that the population is homogeneous in its characteristics and that the possible differences generated can be justified from the specific training plan of the study.

Table 3. Demographic characterization data of the population

Group	Age (years)	p	Mass (Kg)	p	Height (cm)	p
Experimental	11.94±0.58	0.8373	44.41±2.60	0.07072	1.49±0.04	0.8117
Control	11.9±0.4		44.52±1.72		1.47±0.03	

Source: Own elaboration.

In fact, this comparative table allows to see the state of the demographic variables (age, level of instruction, educational level), and it is ratified that both the control group and the experimental group do not present differences that allow significance in any of the three measurable variables in the demographic characterization. In the age variable, there is the greatest similarity in the two groups, which ratifies that the pre-pubescent children are in the age range that the present investigation intends to work; likewise, the mass variable does not present differences in its percentages because there is not even a 0.8% difference between both groups, focusing this variable in an average of 44 kilos per child.8 % of distance between them, centering this variable in average of 44 kilos per child, with respect to the height the differences are not noticeable the rule of the two previous variables is maintained and it is defined once again that the two groups are highly homogeneous, the expectation to know what effects the intervention program arises, perhaps will allow to give accounts at the end of the 10 weeks of intervention.

Speed test data

Table 4. Speed test data of experimental group.

		EXPERIMENTAL GROUP	
NO.	**NAME**	**PRE TEST**	**POS TEST**
1	Subject 1	4.50	4.55
	Subject 2	4.70	4.62
	Subject 3	4.3	4.00
	Subject 4	4.60	4.44
5	Subject 5	4.30	4.22
	Subject 6	4.47	4.32
	Subject 7	5.00	4.49
	Subject 8	5.20	5.12
	Subject 9	5.28	5.18

	Subject 10	5.39	5.25
	Subject 11	4.48	4.34
	Subject 12	4.55	4.43
	Subject 13	5.37	5.31
	Subject 14	5.39	5.24
	Subject 15	5.03	4.55
	Subject 16	5.22	5.12
	Subject 17	5.08	5.01
	Subject 18	4.45	4.35
AVERAGE		4.85	4.70

CONTROL GROUP			
NO.	**NAME**	**PRE TEST**	**POS TEST**
1	Subject 1	5.12	7.58
	Subject 2	4.48	6.58
	Subject 3	4.46	8.26
	Subject 4	5.34	8.43
5	Subject 5	4.40	7.57
	Subject 6	4.40	6.59
	Subject 7	5.20	8.35
	Subject 8	5.18	8.53
	Subject 9	4.36	7.59
	Subject 10	5.28	8.45
	Subject 11	4.59	7.53
	Subject 12	4.50	6.57
	Subject 13	5.15	8.22
	Subject 14	5.03	7.50
	Subject 15	5.33	8.53

	Subject 16	4.58	7.18
	Subject 17	5.45	8.40
	Subject 18	5.16	7.59
AVERAGE		4.89	7.75

Table 5. Speed test data of the control group.

Source: Own elaboration.

Group	Time (s)	Time (s)	p	% difference.
	Pre test	Post test		
Experimental	4.85±0.32	4.7±0.45	0.18	-3.19
Control	4.89±0.3	7.75±1.5	0.29	-2.30

Source: Own elaboration.

Table 6. Speed test data.

Source: Own elaboration.

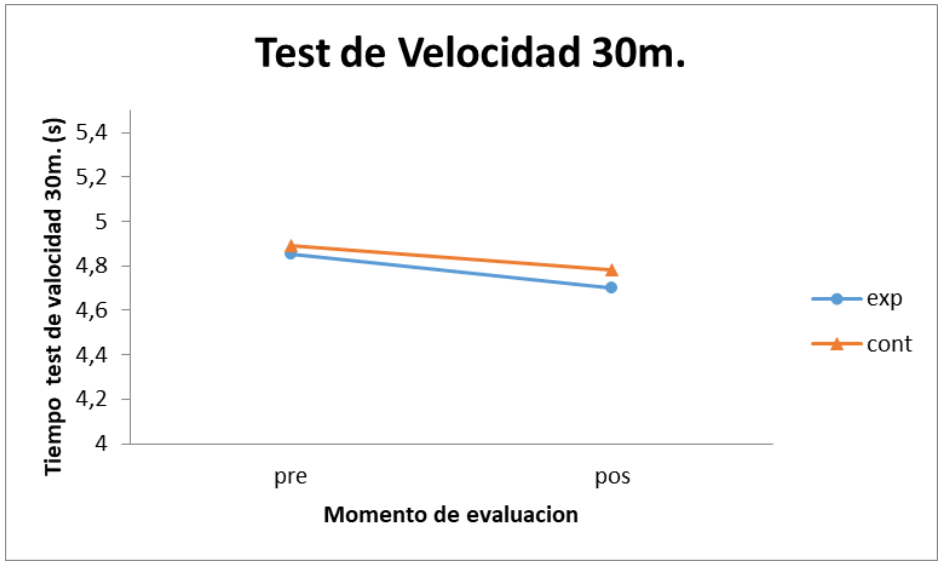

Figure 5. Comparison of 30 m speed test factors.

For the 30-meter test a decrease in time is expected, the input data indicate a homogeneous performance for the two groups at the time of the pre-test (Table 15), with the development of the intervention a greater impact is evidenced in the experimental group according to the pots test allowing to observe a percentage difference (-3.19%). Unlike the control group (-2.3%), this indicates that this variable had a low rate of exploitation of the effects generated by the program, not in vain it can be emphasized that this first variable measured the speed of displacement in 30 m, and that indeed a percentage of differences in favor of the experimental group was achieved, we cannot ratify the above in terms of increased athletic performance (Franco Márquez, 2019). In his study entitled "Effects of strength training combined with plyometric exercises and speed on different variables of physical performance in soccer players aged between 12 and 18 years", in the results showed that the effects of a plyometric work are effective and allow to improve times in the runs in the tests of 5. Therefore, there is a correlation between the studies and allows ratifying that even though in the current study the improvement in speed is low, it allows ratifying that a training process under the plyometric method is clearly applicable.

EXPERIMENTAL GROUP	PRE TEST	POS TEST			Initial Relative		Final Relative		Percentage	Difference of Relative Powers

NO.	NAME	Y (m)	tv (sec)	Y (m)	tv (sec)	Average Mass (Kg)	Initial Power (w)	Power (w/kg)	Final Power (w)	Power (w/kg)	Power Difference	difference	
1	Subject 1	0.28	0.78	0.274	0.553	46.2	329.470	7.131	447.848	9.694	118.378	26%	2.562
	Subject 2	0.29	0.59	0.275	0.572	48.4	476.259	9.840	455.745	9.416	-20.514	-5%	-0.424
	Subject 3	0.28	0.79	0.265	0.544	44.5	310.410	6.976	425.037	9.551	114.627	27%	2.576
	Subject 4	0.27	0.81	0.256	0.542	41.3	274.017	6.635	382.039	9.250	108.022	28%	2.616
5	Subject 5	0.27	0.73	0.256	0.546	39.7	290.470	7.317	364.405	9.179	73.935	20%	1.862
	Subject 6	0.27	0.83	0.246	0.517	43.9	283.883	6.467	408.584	9.307	124.701	31%	2.841
	Subject 7	0.29	0.64	0.274	0.563	46.1	402.444	8.730	440.225	9.549	37.781	9%	0.820
	Subject 8	0.29	0.97	0.274	0.554	45.7	273.357	5.982	442.848	9.690	169.491	38%	3.709
	Subject 9	0.26	0.66	0.246	0.512	47.5	373.534	7.864	446.953	9.410	73.419	16%	1.546
	Subject 10	0.29	0.98	0.273	0.555	44.8	259.762	5.798	432.237	9.648	172.475		3.850
	Subject 11	0.27	0.57	0.265	0.524	45.2	421.822	9.332	447.863	9.908	26.041		0.576
	Subject 12	0.28	0.65	0.274	0.557	44.6	385.986	8.654	429.704	9.635	43.718	10%	0.980
	Subject 13	0.27	0.83	0.256	0.559	41.2	265.300	6.439	369.235	8.962	103.934	28%	2.523

	Subject 14	0.27	0.88	0.266	0.541	40.9	249.369	6.097	393.411	9.619	144.043	37%	3.522
	Subject 15	0.29	0.75	0.274	0.556	47.4	356.028	7.511	457.001	9.641	100.973	22%	2.130
	Subject 16	0.29	0.96	0.274	0.575	40.6	242.037	5.961	378.643	9.326	136.607	36%	3.365
	Subject 17	0.28	0.60	0.274	0.563	45.5	422.337	9.282	434.020	9.539	11.683		0.257
	Subject 18	0.27	0.70	0.245	0.517	45.8	338.868	7.399	425.921	9.300	87.053	20%	1.901
AVERAGE		0.28		0.26		44.41	330.85	7.41	421.21	9.48	90.35	21.85%	2.07
													1.534
													1.238414

Table 7: Abalakov jump test data for the experimental group.

Source: Own elaboration.

CONTROL GROUP		PRE TEST		POS TEST		Average Mass (Kg)	Initial Power (w)	Initial Relative Power (w/kg)	Final Power (w)	Final Relative Power (w/kg)	Power Difference	Percentage difference	Relative Power Difference
NO.	NAME	Y (m)	tv (sec)	Y (m)	tv (sec)								
1	Subject 1	0.29	0.74	0.274	0.559	45.3	354.310	7.821	434.886	9.600	80.577		1.779
	Subject 2	0.28	0.57	0.281	0.589	45.7	432.931	9.473	426.570	9.334	-6.362	-1%	-0.139
	Subject 3	0.29	0.55	0.281	0.523	44.2	461.828	10.449	465.129	10.523	3.301		0.075
	Subject 4	0.29	0.58	0.273	0.520	41.8	404.546	9.678	429.334	10.271	24.788		0.593
5	Subject 5	0.28	0.60	0.254	0.489	44.4	411.952	9.278	452.027	10.181	40.074	9%	0.903
	Subject 6	0.30	0.87	0.275	0.545	44.9	297.945	6.636	443.250	9.872	145.305	33%	3.236
	Subject 7	0.29	0.67	0.276	0.576	46.5	398.230	8.564	435.921	9.375	37.691	9%	0.811
	Subject 8	0.28	0.53	0.285	0.594	45.6	463.880	10.173	428.072	9.388	-35.808	-8%	-0.785
	Subject 9	0.28	0.58	0.264	0.475	46.2	445.409	9.641	502.516	10.877	57.106	11%	1.236
	Subject 10	0.27	0.54	0.270	0.532	46.8	468.547	10.012	466.227	9.962	-2.321	0%	-0.050
	Subject 11	0.29	0.62	0.271	0.536	46.6	423.912	9.097	462.474	9.924	38.562	8%	0.828
	Subject 12	0.29	0.67	0.285	0.601	45.4	387.622	8.538	421.675	9.288	34.053	8%	0.750

	Subject 13	0.27	0.51	0.264	0.432	41.6	434.330	10.441	498.276	11.978	63.946	13%	1.537
	Subject 14	0.28	0.60	0.273	0.584	42.3	390.519	9.232	386.857	9.146	-3.662	-1%	-0.087
	Subject 15	0.27	0.54	0.264	0.497	43.7	434.593	9.945	454.111	10.392	19.518	4%	0.447
	Subject 16	0.28	0.55	0.271	0.534	44.2	447.993	10.136	439.000	9.932	-8.993	-2%	-0.203
	Subject 17	0.30	0.65	0.271	0.513	44.5	397.680	8.937	461.093	10.362	63.413	14%	1.425
	Subject 18	0.28	0.58	0.235	0.387	41.7	399.251	9.574	496.305	11.902	97.054	20%	2.327
AVERAGE		0.29	0.61	0.27	0.53	44.52	414.19	9.31	450.21	10.13	36.01	7.79%	0.82
												33%	0.998
													0.9989

Table 8: Abalakov jump test data control group.

Source: Own elaboration.

Group	Height (cm)	Height (cm)	P	% Difference in relation to final status.
	Pre test	Post test		
Experimental	26.47±5.62	28.02±3.45	0.22	5.53
Control	27.02±6.24	28.59±5.59	0.15	5.49

Table 9: Abalakov jump test data.

Source: Own elaboration.

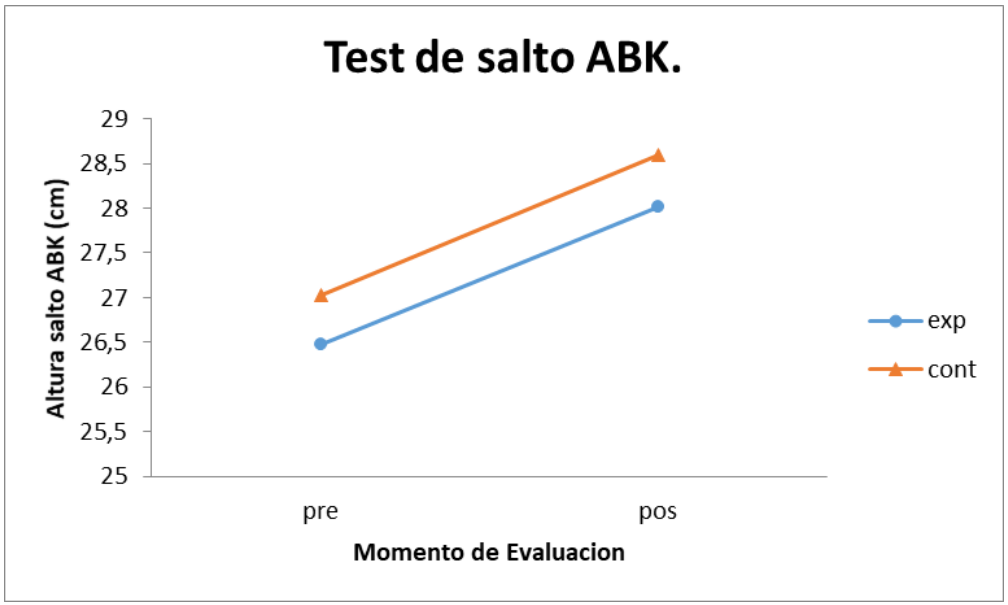

Figure 6. Comparison of Abalakov jump test factors.

The evaluation of the jumping ability to measure power, starting with the ABK jump, the data obtained by the participants are in the expected ranges for beginner athletes in team disciplines, the standard deviations shown in table 18 for the pre-test indicate a homogeneity of the participants at the beginning of the training process. This variable in particular had no effect in relation to the comparison between the factors as can be seen in the illustration.

It is important to remember that the Abalakov jump allows using the height developed in the vertical jump to measure the power of the legs, the fact that there are no differences between the two groups does not mean a loss, when looking at the values of the pre-test and post-test there is a very equal gain in the two groups, it can be indicated that the non-difference may be due to aspects such as the domain of the pre-pubescent in the contact platform, it is relevant to indicate that the intervention time may be short, but based on (Kraemer et al., 1999) who postulate that the gains will be mostly evident if the hormonal changes that occur during puberty (first phase of adolescence) are taken into account, these studies consider that the gains will be mostly evident if the hormonal changes that occur during puberty (first phase of adolescence) are taken into account. Ivolek (1999), who postulates that the gains will be mostly evident if the hormonal changes that occur during puberty (first phase of adolescence) are taken into account, these studies consider that this stage is essential to cause physiological adaptations through training, according to the postulate of (Kraemer et al., 1999), according to the postulate of (Kraemer et al., 1999), who postulate that the

gains will be mostly evident if the hormonal changes that occur during puberty (first phase of adolescence) are taken into account. Ivolek (1999) applies to the research and allows to ratify that although there is no gain, it is possible to create a larger motor base in athletes who face these plyometric works at early ages.

EXPERIMENTAL GROUP		PRE TEST		POS TEST		Average Mass (Kg)	Initial Power (w)	Initial Relative Power (w/kg)	Final Power (w)	Final Relative Power (w/kg)	Power Difference	Percentage difference	Relative Power Difference
NO.	NAME	Y (m)	tv (sec)	Y (m)	tv (sec)								
1	Subject 1	0.27	0.58	0.254	0.453	46.2	427.468	9.253	506.731	10.968	79.264	16%	1.716
	Subject 2	0.28	0.59	0.255	0.472	48.4	453.311	9.366	512.105	10.581	58.794	11%	1.215
	Subject 3	0.28	0.69	0.255	0.445	44.5	355.463	7.988	499.996	11.236	144.533	29%	3.248
	Subject 4	0.27	0.71	0.246	0.442	41.3	312.884	7.576	450.159	10.900	137.275	30%	3.324
5	Subject 5	0.27	0.63	0.246	0.446	39.7	334.444	8.424	428.664	10.798	94.220	22%	2.373
	Subject 6	0.27	0.73	0.236	0.417	43.9	322.665	7.350	485.932	11.069	163.267	34%	3.719
	Subject 7	0.28	0.54	0.264	0.463	46.1	460.131	9.981	515.790	11.189	55.659	11%	1.207
	Subject 8	0.28	0.87	0.264	0.554	45.7	294.604	6.446	426.680	9.337	132.076	31%	2.890
	Subject 9	0.26	0.56	0.236	0.412	47.5	439.592	9.255	532.839	11.218	93.247	17%	1.963
	Subject 10	0.27	0.78	0.263	0.455	44.8	307.721	6.869	507.936	11.338	200.215	39%	4.469
	Subject 11	0.27	0.61	0.235	0.424	45.2	397.066	8.785	490.808	10.859	93.742		2.074
	Subject 12	0.28	0.55	0.264	0.457	44.6	456.809	10.242	504.985	11.323	48.176	10%	1.080
	Subject 13	0.26	0.63	0.246	0.459	41.2	336.254	8.162	432.261	10.492	96.006	22%	2.330
	Subject 14	0.28	0.58	0.256	0.441	40.9	393.165	9.613	464.442	11.356	71.277		1.743
	Subject 15	0.26	0.55	0.235	0.356	47.4	449.178	9.476	613.010	12.933	163.832	27%	3.456
	Subject 16	0.27	0.76	0.254	0.475	40.6	282.589	6.960	424.852	10.464	142.263	33%	3.504
	Subject 17	0.27	0.50	0.254	0.463	45.5	485.655	10.674	489.238	10.752	3.583		0.079
	Subject 18	0.26	0.50	0.235	0.417	45.8	455.993	9.956	506.533	11.060	50.540	10%	1.103
AVERAGE		0.27	0.63	0.25	0.45	44.41	386.94	8.69	488.50	10.99	101.55	20.99%	2.31
												39 %	1.344
													1.15931

Table 10: Counter-movement jump test data CMJ experimental group.

Source: Own elaboration.

CONTROL GROUP		PRE TEST		POS TEST		Average Mass (Kg)	Initial Power (w)	Initial Relative Power (w/kg)	Final Power (w)	Final Relative Power (w/kg)	Power Difference	Percentage difference	Relative Power Difference
NO.	NAME	Y (m)	tv (sec)	Y (m)	tv (sec)								
1	Subject 1	0.28	0.63	0.262	0.449	46.2	410.224	8.879	527.380	11.415	117.156	22%	2.536
	Subject 2	0.27	0.50	0.243	0.479	48.4	502.722	10.387	482.044	9.960	-20.679	-4%	-0.427
	Subject 3	0.25	0.51	0.253	0.413	44.5	434.056	9.754	533.246	11.983	99.190		2.229
	Subject 4	0.28	0.44	0.261	0.435	41.3	508.737	12.318	485.316	11.751	-23.421	-5%	-0.567
5	Subject 5	0.25	0.54	0.230	0.379	39.7	366.047	9.220	472.826	11.910	106.779	23%	2.690
	Subject 6	0.27	0.66	0.242	0.435	43.9	344.565	7.849	477.693	10.881	133.128	28%	3.033
	Subject 7	0.26	0.59	0.231	0.466	46.1	402.343	8.728	448.484	9.728	46.141	10%	1.001
	Subject 8	0.28	0.45	0.261	0.484	45.7	547.362	11.977	482.837	10.565	-64.525	-13%	-1.412
	Subject 9	0.27	0.43	0.234	0.405	47.5	596.361	12.555	537.451	11.315	-58.909	-11%	-1.240
	Subject 10	0.27	0.49	0.261	0.427	44.8	478.346	10.677	537.130	11.990	58.784	11%	1.312
	Subject 11	0.28	0.59	0.234	0.426	45.2	417.108	9.228	486.424	10.762	69.316	14%	1.534
	Subject 12	0.26	0.57	0.242	0.561	44.6	389.939	8.743	377.400	8.462	-12.539	-3%	-0.281
	Subject 13	0.26	0.48	0.234	0.412	41.2	441.800	10.723	459.424	11.151	17.624	4%	0.428
	Subject 14	0.28	0.59	0.265	0.474	40.9	371.804	9.091	447.329	10.937	75.524	17%	1.847

	Subject 15	0.27	0.50	0.266	0.414	47.4	492.336	10.387	595.797	12.570	103.462	17%	2.183
	Subject 16	0.27	0.51	0.271	0.502	40.6	424.871	10.465	428.950	10.565	4.079		0.100
	Subject 17	0.29	0.53	0.245	0.403	45.5	478.650	10.520	541.497	11.901	62.848	12%	1.381
	Subject 18	0.28	0.49	0.273	0.317	45.8	521.903	11.395	773.930	16.898	252.028	33%	5.503
AVERAGE		0.27	0.53	0.25	0.44	44.41	451.62	10.16	505.29	11.37	53.67	9.62%	1.21
												33%	3.003
													1.733028

Table 11: Data from the CMJ counter-movement jump test in the control group.

Source: Own elaboration.

Group	Height (cm)	Height (cm)	p	% Difference
	Pre test	Post test		
Experimental	24.98±4.56	27.32±3.85	0.02	8.67
Control	25.04±3.95	26.98±4.25	0.15	7.25

Table 12: CMJ counter-movement jump test data.

Source: Own elaboration.

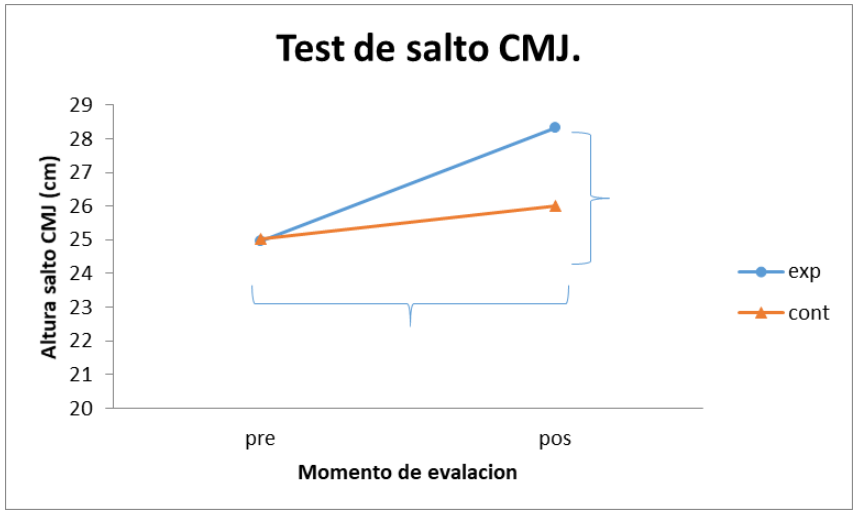

Figure 7. Comparison of CMJ jump test factors.

The values of the CMJ jump test are above the expected values for a population of children of the same age, evidently this condition is justified by the regular sports practice that the population of the object of this study maintains, the input data evidences an equality of the participants since when analyzing the standard deviation data, a low value is evidenced, indicating a homogeneous performance. With the development of the intervention a greater impact (% difference) is evidenced in the experimental group, this is corroborated with the results of the ANOVA, which establish an interaction of the factors analyzed, being that the experimental group presents significant differences between the pre- and post-test moment and also presents significant difference with the post-test of the control group.

In accordance with the results of the present study, it is important to clarify that this test was not applied to measure fatigue levels in the children; this CMJ test was used in this case to evaluate jumping power, specifically to measure the force-velocity profile from the height of the jump in centimeters. Although it is true that gains are evidenced in the experimental group, they can be ratified to the extent that it is a test that presents greater ease in the execution by the practicing children, the body initiation and the placement of the hands ensure the posture of the children and facilitates its execution. In accordance with the results obtained at the Universidad del Valle, in the research called “Training program focused on strength through multi-jumps applied to soccer players of the sparrow category of the Universidad del Valle Cali sports club”, the average in the Abalakov test, according to measurements taken weekly, during the development of the preparation of the athletes of the sparrow category (11/12 years old), it was found that the plyometric training caused significant changes in the manifestation of the jump reaching the maximum development with 13.5% in week 8. (Villalobos Camacho, 2015).

EXPERIMENTAL GROUP		PRE TEST		POS TEST		Average Mass (Kg)	Initial Power (w)	Initial Relative Power (w/kg)	Final Power (w)	Final Relative Power (w/kg)	Power Difference	Percentage difference	Relative Power Difference
NO.	NAME	Y (m)	tv (sec)	Y (m)	tv (sec)								
1	Subject 1	0.22	0.48	0.215	0.401	46.2	419.576	9.082	484.374	10.484	64.798	13%	1.403
	Subject 2	0.24	0.48	0.235	0.412	48.4	475.300	9.820	541.554	11.189	66.254	12%	1.369
	Subject 3	0.24	0.58	0.215	0.405	44.5	366.864	8.244	463.235	10.410	96.372	21%	2.166
	Subject 4	0.24	0.52	0.214	0.402	41.3	380.518	9.214	430.514	10.424	49.996	12%	1.211
5	Subject 5	0.22	0.52	0.206	0.389	39.7	330.152	8.316	411.463	10.364	81.311	20%	2.048
	Subject 6	0.23	0.50	0.216	0.387	43.9	401.939	9.156	479.134	10.914	77.195	16%	1.758
	Subject 7	0.23	0.50	0.203	0.413	46.1	405.075	8.787	444.779	9.648	39.704	9%	0.861
	Subject 8	0.24	0.57	0.205	0.454	45.7	387.617	8.482	403.469	8.829	15.852	4%	0.347
	Subject 9	0.23	0.46	0.225	0.403	47.5	475.236	10.005	520.482	10.958	45.246	9%	0.953
	Subject 10	0.24	0.58	0.224	0.395	44.8	370.005	8.259	498.394	11.125	128.389	26%	2.866
	Subject 11	0.23	0.61	0.215	0.374	45.2	340.426	7.532	509.049	11.262	168.623	33%	3.731
	Subject 12	0.23	0.45	0.245	0.357	44.6	461.242	10.342	599.669	13.445	138.427	23%	3.104
	Subject 13	0.23	0.54	0.224	0.379	41.2	337.690	8.196	476.629	11.569	138.938	29%	3.372
	Subject 14	0.25	0.45	0.236	0.401	40.9	449.592	10.992	470.789	11.511	21.196	5%	0.518
	Subject 15	0.23	0.43	0.215	0.306	47.4	505.666	10.668	652.453	13.765	146.787	22%	3.097
	Subject 16	0.23	0.56	0.225	0.395	40.6	330.177	8.132	453.885	11.179	123.709	27%	3.047
	Subject 17	0.24	0.40	0.225	0.373	45.5	544.198	11.960	536.754	11.797	-7.445	-1%	-0.164
	Subject 18	0.24	0.50	0.215	0.402	45.8	423.604	9.249	480.772	10.497	57.168	12%	1.248
AVERAGE		0.24	0.51	0.22	0.39	44.41	411.38	9.25	492.08	11.08	80.70	16.18%	1.83
												33%	1.333
													1.15448644

Table 13: Squat Jump test data of the experimental group.

Source: Own elaboration.

CONTROL GROUP		PRE TEST		POS TEST		Average Mass (Kg)	Initial Power (w)	Initial Relative Power (w/kg)	Final Power (w)	Final Relative Power (w/kg)	Power Difference	Percentage difference	Relative Power Difference
NO.	NAME	Y (m)	tv (sec)	Y (m)	tv (sec)								
1	Subject 1	0.24	0.53	0.214	0.419	46.2	414.173	8.965	462.053	10.001	47.880	10%	1.036
	Subject 2	0.22	0.42	0.214	0.403	48.4	508.216	10.500	504.686	10.427	-3.530	-1%	-0.073
	Subject 3	0.23	0.47	0.222	0.446	44.5	433.304	9.737	433.753	9.747	0.449	0%	0.010
	Subject 4	0.24	0.43	0.234	0.403	41.3	454.365	11.002	469.619	11.371	15.253		0.369
5	Subject 5	0.21	0.44	0.213	0.397	39.7	371.063	9.347	416.500	10.491	45.437	11%	1.145
	Subject 6	0.22	0.56	0.214	0.415	43.9	337.921	7.698	442.660	10.083	104.739	24%	2.386
	Subject 7	0.21	0.50	0.204	0.406	46.1	378.814	8.217	454.228	9.853	75.414	17%	1.636
	Subject 8	0.24	0.43	0.223	0.424	45.7	500.647	10.955	471.098	10.308	-29.549	-6%	-0.647
	Subject 9	0.21	0.41	0.202	0.395	47.5	486.669	10.246	475.635	10.013	-11.035	-2%	-0.232
	Subject 10	0.23	0.43	0.213	0.403	44.8	475.438	10.612	464.968	10.379	-10.470	-2%	-0.234
	Subject 11	0.21	0.49	0.205	0.396	45.2	389.914	8.626	457.502	10.122	67.587		1.495
	Subject 12	0.22	0.48	0.214	0.461	44.6	402.150	9.017	405.792	9.098	3.642		0.082

	Subject 13	0.21	0.40	0.211	0.398	41.2	428.545	10.402	428.919	10.411	0.374	0%	0.009
	Subject 14	0.24	0.48	0.223	0.404	40.9	404.961	9.901	441.497	10.795	36.537	8%	0.893
	Subject 15	0.25	0.41	0.224	0.404	47.4	554.938	11.708	513.961	10.843	-40.976	-8%	-0.864
	Subject 16	0.25	0.48	0.233	0.408	40.6	412.873	10.169	454.831	11.203	41.959	9%	1.033
	Subject 17	0.22	0.45	0.215	0.398	45.5	444.318	9.765	482.199	10.598	37.881	8%	0.833
	Subject 18	0.25	0.43	0.245	0.378	45.8	530.029	11.573	580.642	12.678	50.613	9%	1.105
AVERAGE		0.23	0.46	0.22	0.41	44.41	440.46	9.91	464.47	10.47	24.01	5.29%	0.55
												24%	0.744
													0.862799

Table 14: Squat Jump test data control group.

Source: Own elaboration.

Group	**Height (cm)** **Pre test**	**Height (cm)** **Post test**	**p**	**% Difference,**
Experimental	21.98±7.42	23.64±9.98	0.05	7.02
Control	21.78±6.95	22.98±7.85	0.78	5.22

Table 15: Squat Jump test data.

Source: Own elaboration.

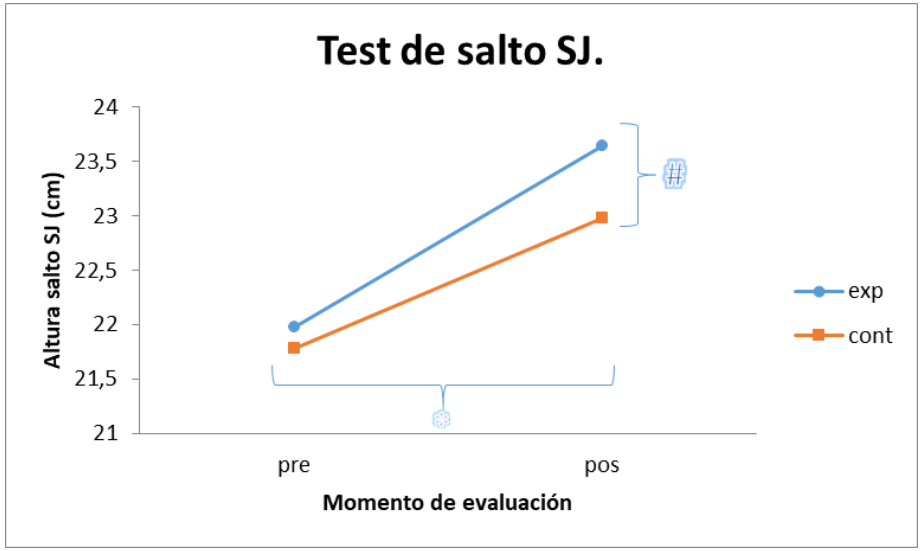

Figure 8. Comparison of CMJ jump test factors.

The results for the SJ jump test show a behavior similar to that of the previous variable, the expected results for this age are somewhat surpassed in this study, and it is related to the practice of several years in the sport, which makes the child athletes have a predisposition to movement. In this sense, the low standard deviation indicates a homogeneous performance, the greater impact present in the experimental group and an interaction between the factors that indicates differences between moments and groups, benefiting the experimental group with a greater performance after the application of the training plan, presenting a significant difference with the post-test of the control group.

For children of this age, it is evident that the start of the movement from squat, executed at the beginning of the test, ensures the participant the confidence to achieve a controlled execution that allows to see its maximum capacity of rejection expressed in centimeter. The results reported in this study correlate with the results reported in the study conducted by (Nielsen et al., 1980). They conducted a study with women from 7 to 19 years old, to measure and compare three manifestations of muscle strength in the lower body. According to Asmussen (1980), a study was conducted with women from 7 to 19 years of age, to measure and compare three manifestations of muscle strength in the lower body, they used the squat jump, the height of the vertical jump and the acceleration in running sprints over a distance of 10 m, in the results it is evident that the gains reported in the squat jump test are similar to those presented here, the results of our research establish an interaction of the factors analyzed, this is corroborated by the results of the ANOVA, as reported (% difference).

5. Discussion

This research aims to determine the effects on power and speed, developing an intervention program in pre-pubertal children, from the application of plyometric training. In this sense, the intervention plan was organized by directing all the exercises in order to meet the above, it should be clarified that per session 7 exercises were worked, organized as follows, 4 exercises for lower extremities, 1 exercise for the corl zone and 2 exercises for the upper train, always looking for the body structure of the pre pubers, to maintain strengthening in these areas, avoiding that at the time of the evaluations the executions were affected by body imbalances, understanding that the plyometric work is not only based on the lower train.

In the main facts, it is definitely determined that during the intervention there were no injuries in any of the practicing children; likewise, it was evident that the polymetry not only develops power and speed but also improves the physical condition of the trainees, in this sense the progress observed in children who had less time of practice in indoor soccer and therefore less motor experience, which is similar to that described in the research by (Franco Márquez, 2019).

Now the data reported in this study show some progress in terms of the specific development of the heights of the jumps, showing that plyometrics effectively generates changes in power and speed in pre-pubertal children, because the gains reported in the lower limbs allow to show it, perhaps it remains to be seen what is achieved at the level of the upper limbs, but the exercises mostly developed in this work were performed for the lower body and that some differentiated exercises were added to the abdomen and arms only with the intention of establishing a minimum balanced development. Such effects can be contrasted with the reports made in the study of were also evident in the study conducted by Behringer et al. (2010), in which it is manifested that the gains from strength training to other motor skills (jumping, sprinting or throwing) are greater in less mature individuals.

In this study, the data reported by the Abalakov jump test did not report significant differences in the two groups under study, but it is important to mention that there were no decreases in the heights reported. On the contrary, both control and experimental groups showed progress in the results of this test. By defining that there are no significant changes between both groups is not assuring that there were no differences, what can be assured is that both groups advanced with similarity in the data and that these data do not allow establishing differences, but these data of both groups agree with what was reported in the study carried out in the sparrow category of the Universidad del Valle Cali sports club. The objective of the study was to determine the effects of a program of 8 weeks of plyometric training on the manifestation of strength/power for the Abalakov test, where they performed weekly evaluations during 8 weeks of intervention, unlike the research in which two assessments were made in week 1 and week 10 but in the two investigations are reported improvement in young children who for the two studies have similar ages 11 to 12 years old.

6. Conclusions

- The application of the 4 pre-tests allows to know the initial state of the pre-puberts, likewise, the correlation of these tests with both variables of study allow to ratify that we were able to evaluate the power and speed in the two moments of evaluation, obtaining results that allowed to ratify the application of a plyometric work, under the use of self-loads.

- It is confirmed that the intervention plan designed, from the theoretical point of view, structured the development of power and speed, using plyometrics as the basis of this study, the exercises mentioned and selected therein allowed the children to progressively advance in the levels of complexity.
- The intervention plan was developed in the established times and demonstrated the applicability of plyometrics in these ages, the work developed during the 10 weeks had a positive impact on the entire experimental group and even when the differences between both groups were not highly significant, no injury was caused and the motor base of the pre-puberts was broadened.
- It is evident that plyometric training significantly favors capacities such as movement speed, while in capacities such as power, the significance is not highly representative in pre-pubertal children. The differences of the two groups studied allow to identify that it is necessary to establish a longer period of training, but it is evident that it is not necessary to wait for the development of the youngsters to advance muscular strengthening works, with this type of research the subjects are predisposed to increase the training loads in future categories, loads that are characteristic of the competitive processes of this age group.

7. Recommendations

- The professionals in charge of guiding the training process in these ages should know and apply the theoretical bases of the sensitive bases of development of prepubertal children, the principles of training in children and young people to apply Plyometric works, which allow to organize and plan methodological structures, in order to carry out a coherent process with respect to the age of the subject.
- It is important to note that the intervention program designed in this research was not applied in a whole stage of the training plan of the sports training school, for this reason it is interesting to be able to apply a plyometric program during a whole stage, during a whole preparatory period.
- Although it is true that pre-pubertal children are in the transition to the development stage and that hormonal levels are somewhat different, these cannot be factors that limit the application of this type of work, since this age is a clear possibility to increase the predisposition to strength work itself.

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