

Plyometrics in football and basketball. Expected improvements vs real

Pliometría contextualizada en el fútbol y el baloncesto. Mejoras esperadas vs reales.

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Abstract

The aim of this research is to prove the benefits which we really can get with a mesocycle of plyometric exercise with diluted stimulus because of the characteristics of team sports, in which we need to improve a lot of different physical, technical, tactical and psychological requirements and playing every weekend. By this way we try to establish a balance between the improvements and benefits that plyometrics report as well as its disadvantages. Two different groups of athletes were studied, both of them were men. The first group were basketball players who belong to the LEB-Adecco Plata (N=13) and the second one was a junior football team that plays in Galician League (N=14). Both groups made several sessions with plyometric exercise, these sessions varied between 20 and 35', without including the warm up. The interventions consisted on 5 sessions plus the Test and Re-Test in the case of the football team, and 10 sessions plus the Test and Re-Test in the case of the basketball team. During the research it is explained how the progression is in each group pointed out the differences between them, as well as the improvements achieved in each group and the possible explanations of these differences. The goal is not to compare the results in an absolute way, because we have two different interventions, but rather, analyse how useful is this method applied to increase the specific performance factors. The Test made consisted on the performance of 4 jumps in the case of basketball (SJ modified, CMJ, ABK and DJ) and 3 in the case of football (CMJ, ABK and DJ), every jump was done in a jump platform.

Keywords

Plyometrics, strength, basketball, football.

Resumen

El objetivo de este trabajo es experimentar las mejoras que realmente se pueden llegar a obtener realizando un mesociclo de orientación pliométrica de carga diluida, como lo demandan los deportes colectivos, en los que hay que implementar muchas cualidades físicas, técnico-tácticas y psicológicas diferentes, con la necesidad de competir semanalmente. De esta forma se pretende establecer un balance entre las mejoras y beneficios que aporta el trabajo pliométrico y los costes o posibles desventajas asociadas a este tipo de trabajo. Se analizaron dos grupos de deportistas, todos ellos hombres, el primero de baloncesto, perteneciente a la LEB-Adecco Plata (N=13) y el segundo un equipo de fútbol juvenil perteneciente a Liga Gallega (N=14). Ambos grupos realizaron sesiones orientadas hacia la pliometría, dichas sesiones variaban en duración entre 20 y 35', sin incluir el contenido de calentamiento. Las intervenciones variaban en número de sesiones, siendo de 5 sesiones más el Test y el Re-Test en el caso del fútbol, y 10 sesiones más Test y Re-Test en el caso del baloncesto. Se explica la progresión del trabajo realizado en ambos grupos explicando las diferencias entre dichos procesos, así como las mejoras obtenidas en ellos y las posibles explicaciones de éstas. El objetivo no es comparar los resultados de forma absoluta, ya que son intervenciones diferentes, sino por el contrario, valorar cómo de útil es una intervención específica para cada deporte en el aumento de los factores de rendimiento específicos del mismo. Los Test realizados consistían en la realización de 4 saltos en el caso del baloncesto (SJ modificado, CMJ, ABK y DJ) y 3 en el caso del fútbol (CMJ, ABK y DJ), todos ellos testados con una plataforma de saltos.

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Palabras Clave

Pliometría; fuerza; baloncesto; fútbol.

Introduction

Plyometrics is a method to develop the reactive strength (elastic-explosive strength and reflex-elastic-explosive strength) which uses the Stretch-Shortening Cycle (CSS) to increase the strength produced by the muscle-skeletal system. When an eccentric action precedes a concentric one, the final concentric strength will be bigger, this is the essence of the CSS (Brown & Ferrigno, 2007). To take advantage of the CSS we need a very short period of time between the eccentric and concentric phases, which is called coupling time, the smaller this time, the bigger additional energy will be kept by the elastic elements in series (muscle's tendons) and in parallel (conjunctive tissue which form the membrane of the muscle fibers

and their beams) (Becerra & Cáceres, 2004). There are two types of plyometrics depending on its aggressiveness level upon the athlete's joints: Low impact plyometrics, which improves basically the elastic-explosive strength, consists in performing an eccentric phase fast, but with a minimum depth degree, followed by an explosive concentric action, finishing falling without joining any other jump or other action. And the high impact plyometrics, whose main difference with the other type is that in this one we join other high intensity actions, taking advantage of the myotatic reflex, by this way we will use height platforms to fall from them to trigger this reflex, we will also join jumps and other actions... (García, 2013). Doing this way we can express, generally speaking, that the plyometrics, by means of its two types, pretends to optimize the athlete's ability of implementing the use of the elastic properties of the elastic components in series and in parallel, as well as improving the myotatic reflex use.

The aim of this paper is to test if the expected improvements with a mesocycle of plyometrics are similar of these ones found by the researchers in control research, which was made with great training means and objective control load gadgets. The intervention will be formed by sessions in which the players will receive plyometrics stimulus of diluted load, because the period of study is intra-season and being team sports, other physical, tactical, technical and psychological qualities should be developed, as well as compete every week. Thus, it is pretended to relativize the improvements in a real situation, real circumstances, in comparison with the improvements found in the lab or in camp researches with very controlled conditions.

The justification of this plyometric workout is based in the improvements found in numberless researches, which confirmed gains in running economy without increases in the $VO_2\text{máx}$, by means of the improvements of the neuromuscular characteristics, specially the reactivity of the ankle joint (Paavolainen, Häkkinen, Hämmäläinen, Nummela & Rusko, 1999). Improvements in 10m time (Marques, Pereira, Reis and Van den Tillaar, 2013). In 15m of maximum acceleration, likewise in 20m and 30m, test and qualities basics in team sports (Arazi y Asadi, 2011). Improvements in flight time and in jump height in test like Squat Jump (SJ), CMJ (Countermovement Jump), ABK (Abalakov Jump) and DJ (Drop Jump) (Sağiroğlu, Ateş, Önen, Kayatekin, Semin, 2011; Papanikolaou, 2013; Perez-Gomez, Olmedillas, Delgado-Guerra, Ara, Rodríguez, Arteaga, Chavarren & Calbet, 2008). It was

also found improvements in acceleration ability in the first steps, as well as in deceleration ability, joining these two improvements, we have an increase in the ability of changing the speed, the direction and the sense of movement, core competencies in team sports (Hernández & García, 2012; Garcia & Mendoza, 2006). As well as different strength manifestations, being the elastic-explosive and reflex-elastic-explosive the ones which experiment the bigger improvement (Arazi & Asadi, 2011; Sağıroğlu, Ateş, Önen, Kayatekin, Semin, 2011; Papanikolaou, 2013; Perez-Gomez, Olmedillas, Delgado-Guerra, Ara, Rodríguez, Arteaga, Chavarren, & Calbet, 2008).

Improvements were also reported in agility and in any exercise characterized by request high values of power (Asadi, 2013; Shelvam, Jit & Gurnam, 2013).

Several research have demonstrated, not only an improvement in particular manifestations of strength and speed, but also a transference to specific behaviors, like lay ups, dunks or rebounds, in basketball, as well as the ability to accelerate with the ball and the transference of speed to the ball, in football. (Marques, Pereira, Reis & Van den Tillaar, 2013; Perez-Gomez, Olmedillas, Delgado-Guerra, Ara, Rodríguez, Arteaga, Chavarren, & Calbet, 2008).

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Material and method

It is convenient to define clearly our working groups, so that the explanation of the intervention in each group will be started contextualizing the level, category, age... This is of great importance, because it should be known that the results have been obtained in two specific groups, and it will not be able to extrapolate these results to other performance levels or groups with different characteristics.

This application work has been performed upon two players' group. The first one was a LEB-Adecco Silver team, formed by 11 players of the first team and two more of the youth team. 4 of these 13 players were eliminated. The first one, because he was injured during the test day. Two more because they were sold between both tests, and the last one, one of the youth team, because he did not practice the Re-Test day. Therefore 9 basketball players participated in a whole way in the experiment period, lapsed between the test, the 6 weeks of

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plyometric workout and the Re-Test. All of them fulfilled the requirement to complete all the training sessions (> 90%) since their incorporation to the team during the pre-season until the Re-Test, including all the base work performed during the pre-season and the first weeks of the competitive period.

Previously to the plyometric mesocycle they were developed other necessary contents to face the plyometrics with less injury risk and with greater improvements probabilities. This work consisted first in an anatomic adaptation in the first part of the pre-season, followed by a general strength work. Then, it was performed a strength work oriented to the improvement of maximal hypertrophic strength and the explosive strength simultaneously, through the use of bulgarian contrast method in the majority of the times, plus other contents focused specifically to improve the explosive strength. This decision was motivated by the need of executing works with high angular speed because the competitive period is very close and also the need of improving the maximal hypertrophic strength. It was performed the maximal neural strength period steadily, through intramuscular coordination. Later, it was proceeded to implement the improvement of the elastic-explosive strength and reflex-elastic-explosive strength, through plyometric exercises. The mesocycle was formed by 10 sessions of improvement, and two more to do the Test and Re-Test. All these sessions were carried out during Tuesday and Thursday, being the Saturday the game day. On Tuesday it was performed the main stimulus, and on Thursday the complementary one, with less volume and some contents of agility, quickness, decision-making... because of the impossibility to recover of a stimulus of great magnitude with less than 72h until the competition, having only 48h in this case (García, 2013).

All of these tests were performed using the same tool, a contact platform Din A2 Chronojump Boscosystem.

The start of the study period is the previous day of the first improvement session of elastic-explosive strength. This test consist in the performance of 4 jumps to measure the jump ability of the players, these are a modification of the Squat Jump (SJ modified), this modification consists in allowing the players not keeping their arms on their hips, this decision respond to the inability of some players to do the eccentric phase in a control way

and then to keep the 90 degrees, not doing after that a countermovement; because of this unpredicted factor, I decided to allow the mobility of the arms in return of not producing any countermovement. In addition it is a specific sequence for basketball. The next jump is the Countermovement Jump (CMJ), this jump consist in going down until 90 degrees with a free speed and without doing any isometric phase, execute a concentric explosive phase, all of this with the hands on the hips. The Abalakov Jump (ABK) will be the next jump, which consists in performing a free jump, with freedom for the player to choose the knee angle to form when he is going down, the speed of the eccentric and concentric phase and the arms movement. The last one is the Drop Jump (DJ), which consists in doing the test just after falling of a high platform with the height fixed previously by us, in our case of 40 cm, recording time contact and height.

The second work group was formed by the template of a junior club which belongs to Galician League. Of the whole template, they were 14 players, who participated in the study, being 2 of them eliminated because of not being in Re-Test day.

The procedure was similar to the one in the previous case, with 6 weeks of specific mesocycle, the same as in the basketball group, but the difference is that in this case the work done before the test it was not controlled, therefore, the controlled approximation which culminates with the plyometric mesocycle was not done.

The introduction of the study period was started by the Test, with only 3 jumps, due to the impossibility of having the necessary time to do 4 jumps like in the Basketball group. These: first place CMJ, after that ABK and finally DJ with a 40cm height. All these jumps were executed with the same executing process as in the basketball case. The study upon the football players was formed by 5 sessions plus 2 sessions dedicated to the Test and Re-Test.

The performance of the test consists in the execution of a unique repetition of each jump, with full rest between them to eliminate the possible fatigue effects. It will be allowed a second repetition in these jumps in which the execution is very defective, the technique of the jump was wrong, or not falling completely inside the platform.

There are clear differences between both interventions, the most significant are the different ages of the groups, the experience with strength exercises, and the number of

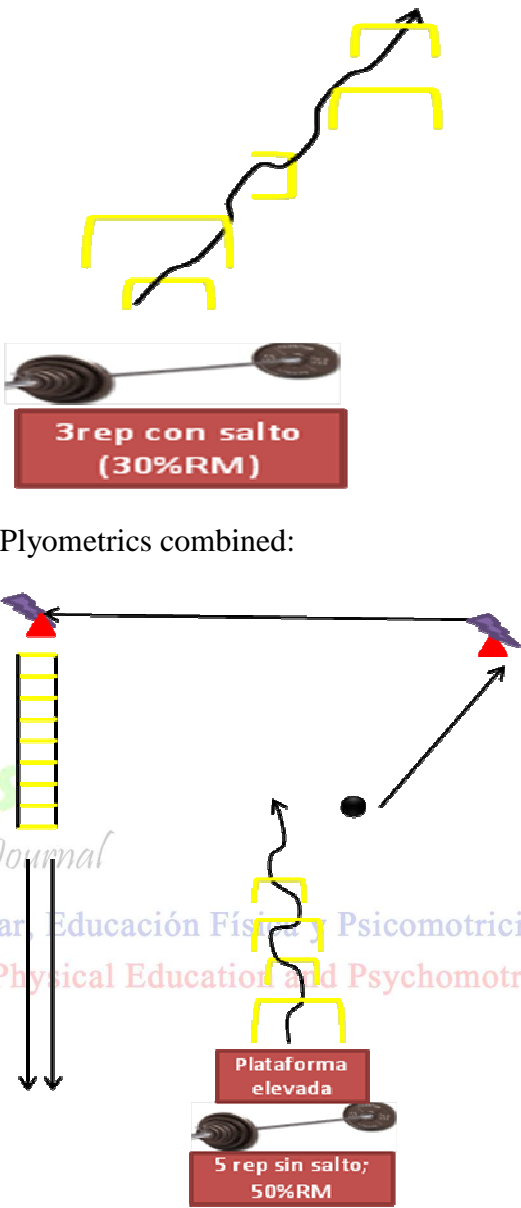
sessions dedicated to the plyometric work (2 per week in the basketball group and just 1 in the football group) and the making of all the previous base work in the basketball case, and not in the football one.

Most of the sessions are based in the complex method of training, which is based in the transference principle between exercises. Depending on the time which we allow between stimulus and the characteristics of them, we will create different transferences. In these sessions I programmed immediate transferences between different followed stimulus, proposing previously the most explosive execution with an external resistance and after, with a rest time between exercise <30" it is proposed next stimulus (around 10" of time frame between stimulus) (Naclerio).

It is not viable to show all the sessions carried out because of the excessive extension for the article, however, I think that exposing a session like an example of both interventions will be enriching. In both cases it will be reflected a central session of the intervention.

Table 1. Seventh intervention session Leb-Plata team.

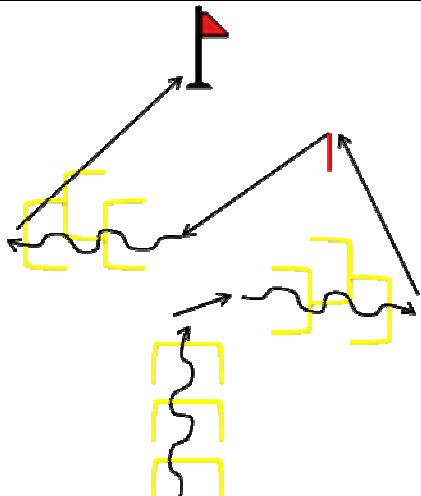
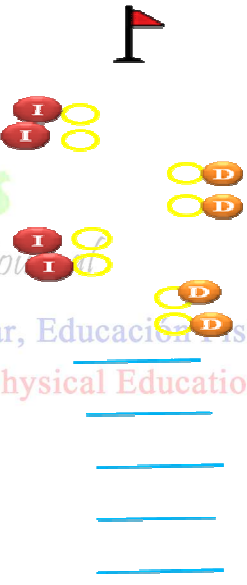
<p><u>Date:</u> 2/12/2014</p> <p><u>Sesión:</u> 7</p>		<p><u>Session name:</u> "pliometría 4"</p>
<p><u>Aims of the session:</u> To improve the elastic-explosive strength by low impact plyometrics and the reflex-elastic-explosive strength by high impact plyometrics. Secondary Objective: To develop agility and hand-eye coordination.</p>		
<p><u>Contents:</u></p> <p><u>Activation phase:</u> This part will be the same during the whole mesocycle (it may vary a bit depending on the main next work).</p>	<p>V=14-16´.</p>	
	<p>I= progressive, from low until moderate and high.</p>	
	<p>D= Very high, almost without rest.</p>	
	<p>Rec= none</p>	
<p><u>Main part:</u> Plyometrics only (the orientation of the obstacles will change in each set) (6 circuits) + plyometrics combined with hand-eye coordination, agility, differentiation ability, decision-making and specific endurance (2-3 circuits). The height used for do the DJ will be the relative strength, i consider that is a key factor to absorb</p>	<p>V1=36rep with jump + 36 jumps; V2=30</p> <p>D1=1:15-1:20; D2=1:5;</p>	<p>Vertical plyometrics:</p>

<p>the impact and jump. By this way we will assimilate the training in a effective way and avoiding injuries.</p>	<p>I1=maximum</p> <p>I2= variable, from maximum or almost maximum until moderate</p>	
<p><u>Tactic part of the session:</u></p>		
<p><u>Regenerative part:</u> 12´(6´ shooting by different positions-6´ jogging-- we try aproximate the intensity to the 80% of the anaerobic treshold-- but always is a softer intensity) + 10-12´of static streching of the</p>		

muscles requested during the session		
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Table 2. fourth intervention session Galician League team.

<p><u>Date:</u> 04/02/2015</p> <p><u>Session:</u> 4</p>	<p><u>Session name:</u> "pliometría 4"</p>	
<p><u>Aims of the session:</u> To improve the elastic-explosive strenght and the reflex-elastic-explosive strenght by high impact plyometrics, and the aceletarion ability. Secondary Objective: To develope agility and hand-eye coordination.</p>		
<p><u>Contents:</u></p> <p><u>Activation phase:</u> This part will be the same during the whole mesocycle (it may vary a bit depending on the main next work).</p>	<p>V=14-16´.</p> <p>I= progressive, from low to moderate and high.</p> <p>D= Very high, almost without "rest".</p> <p>Rec= none</p>	
<p><u>Main part:</u> (vertical plyometrics + plyometrics oriented to horizontal depth. (2 circuits of "depth plyometrics)</p> <p>Height hurdles will vary</p>	<p>V1=42 jumps;</p> <p>V2=20-25";</p>	<p>Vertical plyometrics</p>

<p>depending on the jump abilities of each player, through the realization of 2 groups, according to the results in jump test.</p>	<p>D1=1:15-1:20; D2=1:5;D=1:7</p>	
	<p>I1= maximum; I2= tending to maximum;</p>	<p>Horizontal depth plyometrics:</p> 
<p><u>Tactic part of the session:</u></p>		
<p><u>Regenerative part:</u> 12´(6´ shooting by different positions-6´ jogging-- we try aproximate the intensity to the 80% of the anaerobic treshold-- but always is a softer intensity) + 10-12´of static streching of the</p>		

muscles requested during the session		

In this case we did not use weights because we did not have the possibility of using them in the pitch, and moreover, because of the poor experience with strength exercises of the players. The greatest difference in comparison with the basketball group is that in this case the horizontal depth plyometrics had a greater importance than in the basketball group, in spite of being important in the last one. Secondly, the impossibility of using high platforms to perform DJ, because only with joining the jumps we get enough aggressive stimulus as to develop the reflex-elastic-explosive strenght in this players group.

One of the aims of the intervention was to be the most proficient possible and work the fullest extent possible, for that reason all methodology principles were trying to be accomplished, being one of the most importante ones, the individualization principle.

In football case, we could not almost accomplish this principle because the material we had were some small hurdles, which I requested to jump without flexing the knees or the hips in the air phase to get a tendent to maximum work, for that reason we could not regulate the hurdles height for each player, and we did not also use additional loads, therefore we did not adapt these.

In basketball case we did important adaptations to fulfill, the most important ones were: First, to adapt the hurdles height to each player's level, for which we had the values of the height jump test, plus the observation during the first practices to get the maximum intensity during the workouts. The second important adaptation was to modify the external resistance to the individual characteristics of each player, for what we used Maximum Repetition (RM) percentage to prescribe the weight to use for each player in the half squat, half squat with jump or ankle flex-extensions to develope the triceps surae. Secondly, the sessions with jumps with additional weights (weight vest or a weigh hold by the player) were used different weights depending on the relative strength of the player. In my opinion, by this way I adapted in a right way the load for theses players with a great RM, but also with an

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enormous personal weight, which does not have a good relative strength value, and for that reason put more additional weight could be an excessive load for their joints. The last adaptation consisted in reducing the intensity for these players with soft symptoms of patellar tendinitis, proposing submaximal works and reducing the volume of plyometric work in a veteran player who presented a much higher risk.

Results

Next tables show basketball data.

Table 3. Test and Re-Test jump results, Leb-Silver team.

	TEST 1				TEST 2 (RE-TEST)			
	SJ modified (free arms)	CMJ	ABALAKOV	DJ	SJ modified (free arms)	CMJ	ABALAKOV	DJ
	First test	First test	First test	First test	Second Test	Second Test	Second Test	Second Test
J1	40,62	39,15	51,49	45,29	47,046	36,746	48,871	46,066
J2	46,37	46,25	48,95	50	46,565	43,221	46,477	50,197
J3	44,97	38,76	43,6	43,55	43,914	39,336	43,774	43,619
J4	55,26	48	57,86	52,68	x	x	x	x
J5	58,61	46,32	56,58	53,9	54,685	47,221	56,493	57,459
J6	47,56	30,34	46,75	41,69	47,717	37,314	45,208	40,063
J7	60,5	49,27	67,23	49,04	56,375	50,542	65,305	64,304
J8	42,965	39,52	43,96	45,9	43,179	39,541	43,698	46,214
J9	56	47,25	58,9	52,4	x	x	x	x
J10	x	x	x	x	50,839	41,537	52,431	52,368
J11	32,9	29,84	28,56	26,25	34,6	28,88	32,88	31,25
J12	40	34	43,68	x	x	x	x	x
J13	46,14	35,92	47,5	x	49,302	39,675	46,52	43,345
J14	x	x	x	x	45,491	39,272	45,052	42,215

CI Coordination Index ((ABK-CMJ)/CMJ)*100			Increment average power (f*a) (average of each jump)					Q index (TV/TC)			DJ index (tf-tc)/tc*100		
1er test	2do test	% mejora	SJ	CMJ	ABK	DJ	Mejora total	1er test	2do test	% mejora	1er test	2do test	% mejora
31,52	25,773	-5,75	95,6	-50,20	-57,70	-9,30	-21,60	2,19	2,12	-0,07	111,54	119,04	7,50
5,8378	6,9924	1,15	2,7	-39,00	-21,20	-17,20	-74,70	1,62	1,45	-0,17	61,56	44,78	-16,78
12,487	10,106	-2,38	-9,4	2,50	3,90	-21,20	-24,20	1,68	1,47	-0,21	67,72	46,71	-21,01
20,542													
22,15	16,955	-5,19	-45,1	-13,40	-0,50	-33,20	-92,20	3,50	2,63	-0,87	249,75	162,86	-86,89
54,087	16,543	-37,54						1,76	1,25	-0,51	76,04	22,46	-53,58
36,452	26,187	-10,27	-53,1	18,80	22,50	62,80	51,00	1,71	1,97	0,26	71,30	96,86	25,56
11,235	9,6274	-1,61	-3,2	-29,30	-25,10	6,20	-51,40	1,99	1,98	-0,01	88,06	97,81	9,75
24,656													
	21,428	21,43	3,5	123,30	-23,50	-48,60	54,70						
-4,29	11,561	15,85	33,34	-20,00	88,20	137,10	238,64	0,92	1,41	0,49	-7,39	41,24	48,63
28,471													
32,238	13,884	-18,35	40,7	57,30	170,70	0,00	268,70						
	12,706	12,71											

Table 4. Indexes obtained from Test and Re-Test jump test, Leb-Silver team.

Tabla 5. Improvement percentages of each jump in Leb-Silver team.

% Improvement SJ (modificado)	% Improvement CMJ	% Improvement ABK	% Improvement DJ (35cm)	RSI Reactive Strength Index-- (height/time contact)		
				First Test	Second Test	% improvement
15,820	-6,140	-5,086	1,713	159,47	165,71	3,91
0,421	-6,549	-5,052	0,394	126,26	113,57	-10,05
-2,348	1,486	0,399	0,158	109,70	122,53	11,69
X	X	X	X			
-6,697	1,945	-0,154	6,603	162,84	127,97	-21,41
0,330	22,986	-3,298	-3,903			
-6,818	2,582	-2,863	31,126	132,90	174,74	31,48
0,498	0,053	-0,596	0,684	142,55	149,56	4,92
X	X	X	X			
X	X	X	X			
5,18%	-3,217	15,126	19,048	52,29	87,29	66,93
X	X	X	X			
6,853	10,454	-2,063	X			
X	X	X	X			

Scientific Technical Journal

Following, I am presenting football players data.

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Table 6. Test and Re-Test jump results, Galician League team.

	TEST 1			TEST 2 (RE-TEST)		
	CMJ	ABALAKOV	DJ	CMJ	ABALAKOV	DJ
	First Test	First Test	First Test	Second Test	Second Test	Second Test
J1	29,05	34,54	33,37	30,99	37,6	33,99
J2	30,67	33,42	35,67	33,28	37,21	34,62
J3	33,27	35,17	33,42	34,058	39,35	41,3
J4	31,47	40,28	36,12	32,87	47,31	40,46
J5	33	37,23	39,12	36,71	X	41,09
J6	39,44	33,5	35,80	37,46	36,2	41,27
J7	29,83	35,16	38,56	x	x	x
J8	25,71	24,56	26,10	31,917	32,42	30,23
J9	42,45	52,75	51,55	44,601	50,505	51,493
J10	38,34	43	36,52	37,069	42,553	43,34
J11	34,14	40,6	39,75	33,015	37,307	36,26
J12	35,7	43,7	34,37	x	x	x
J13	41,16	42,13	38,48	38,19	44,35	44,92
J14	21,6	35,6	24,00	28,4	46,371	40,923

Table 7. Index improvements from Test and Re-Tes, Galician league team.

IC Índice de coordinación ((ABK-CMJ)/CMJ)*100			aumento P media(f*a) (media de				Q index (TV/TC)			DJ Índice (tv-tc)/tc*100		
First Test	Second Test	% improvement	CMJ	ABK	DJ	Mejora total	1er test	2do test	% mejora	1er test	2do test	% mejora
18,90	21,33	2,43	26,8	38,69	75,98	141,47	1,11	1,48	32,75	11,30	47,75	36,45
8,97	11,81	2,84	35,242	48,79	150,04	234,07	1,04	1,82	74,77	4,25	82,19	77,94
5,71	15,54	9,83	11,467	56,73	188,91	257,10	0,86	0,86	-0,70	-13,58	-14,18	-0,60
27,99	43,93	15,94	19,38	83,64	6,68	109,70	1,84	1,93	4,83	84,07	92,95	8,89
			38,43		-157,04	-118,61	1,79	1,02	-42,89	78,80	2,12	-76,68
-15,06	-3,36	11,70	-23,85	34,125	76,03	86,30	1,09	1,49	36,42	9,29	49,10	39,81
-4,47	1,58	6,05	96,81	123,54	173,88	394,23	0,51	0,95	86,45	-48,84	-4,61	44,23
24,26	13,24	-11,03	23,2	-22,25	18,26	19,21	2,11401	2,30	8,70	111,40	129,79	18,39
12,15	14,79	2,64	-18	-5,86	254,19	230,33	0,71	1,75	148,08	-29,46	75,00	104,46
18,92	13,00	-5,92	-14,24	-38,75	19,59	-33,40	1,29	1,37	6,50	28,67	37,03	8,36
2,36	16,13	13,77	-35,46	25,407	34,27	24,22	0,90	1,03	14,52	-9,68	3,44	13,11
64,81	63,28	-1,54	100,75	124,33	-17,96	207,12	1,18	1,26	7,12	17,55	25,93	8,37

Table 8. Improvement percentages and Indexes, Galician League team.

% improvement	% improvement ABK	% improvement DJ (50cm)	RSI Reactive Strength Index-- (height/time contact)			IC Índice de coordinación ((ABK-CMJ)/CMJ)*100		
			First Test	Second Test	% improvement	First Test	Second Test	% improvement
6,68	8,86	1,86	71,151	131,617	84,98	18,90	21,33	2,43
8,51	11,34	-2,94	68,861	118,562	72,18	8,97	11,81	2,84
2,37	11,89	23,58	55,331	61,004	10,25	5,71	15,54	9,83
4,45	17,45	12,02	122,441	135,772	10,89	27,99	43,93	15,94
11,24	X	5,04	123,797	72,469	-41,46			
-5,02	8,06	15,28	72,323	106,093	46,69	-15,06	-3,36	11,70
24,14	32,00	15,82	28,904	58,023	100,75	-4,47	1,58	6,05
5,07	-4,26	-0,11	167,915	182,599	8,74	24,26	13,24	-11,03
-3,32	-1,04	18,67	47,183	127,471	170,16	12,15	14,79	2,64
-3,30	-8,11	-8,78	89,729	91,335	1,79	18,92	13,00	-5,92
-7,22	5,27	16,74	62,065	77,182	24,36	2,36	16,13	13,77
31,48	30,26	70,51	63,830	89,157	39,68	64,81	63,28	-1,54

Discussion

Now we will proceed to analyze the most prominent characteristics of the results of each intervention and to compare discordant results between both work groups.

With regards to the basketball team group, an important characteristic is the remarkable difference among different players and different jumps. Thus we find extreme values of each jump in different players. Thereby, in SJ extreme improvements are found like +15,82% and a -6,82%. In CMJ an improvement of +22,98% and a -6,54%. In ABK +15,12% and -5,086%. In DJ +31,13% and -3,021%. Values that express a deterioration it will be attributed to a deficient and unstable technique which makes that a jump could be worsening, in spite of increasing the reactive strength, due to the fact that we only have enough time to 1 or 2 attempts for each jump, in the case that the first one was too deficient. As we can see there are very different improvements, may be due to several factors like the intensity and implication in the sessions carried out, the experience with plyometrics exercise, the start level in which the players were, etc.

In this group it should be noticed that the elasticity index is distorted due to the fact that we allowed to the players the modification of the SJ previously mentioned, and thus we should interpret this data carefully.

Average improvements in these groups in different jumps were the following: In SJ 0,901%. In CMJ 2,62%, in ABK -0,39%. Finally, In DJ team average improvement was 6,98%.

There is not improvement in ABK in basketball group, the percentage -0,39% can be interpreted like keeping the same jump levels. If we observe the individual results we can see that the majority get their level lightly worse and one of them improves in an very sharp way. This occurs because this player had a very low level jump test, so it was quite easy to improve it. Regarding the light worsening of the other players, I consider that it should be interpreted like a 'no improvement', but not like a deterioration. The explanation could be that basketball players have been doing all his sport life Abalakov jumps during games and trainings, so they are relatively insensitive to improve this way of jumping. In addition to this factor, the test is carried out in a relatively small and uncomfortable for them, which affects to the consistence of the results.

Now we will proceed to analyze the football group. In these athletes occurs something similar to what happened in the basketball group, finding uneven results. The justification for this phenomenon is that I did not control the strength work previous to the intervention, each player is in a different level of growth because all the players are 16 years old with the consequent possible difference between the chronologic and biological age in them, plus the difference in the sessions carried out, because some players lost stimulus because of being practicing with the Junio A team. To all these factors we must add all of which also happened in the basketball group.

Thereby, the improvements vary between: CMJ, +31,48% and - 7,22%. In ABK, +32% and -8,11%. In DJ the improvements vary between +70,51% and -8,78%.

The average improvements got by the football players were the following: In CMJ the average improvement was 6,26%, in ABK 10,16% and in DJ the average improvement was 13,97%.

I consider noteworthy that the greatest improvements were obtained in the football group, being strange if we notice that this program was formed by fewer total sessions and there was not the possibility of creating the work base which facilitate getting greater improvements. Nevertheless, these results can be easily explained if we analyze the players' age, who had a big range of improvement, because of the level of the values from which they started. Another factor is the little experience using plyometrics methods and strength methods in general, in comparison with the basketball players, being for that reason much more sensitive to these sessions. The last logical explanation is that the specific nature of the basketball leads to the performance of 3'1-4'1 jumps per minute (Bober, Rutkowska-Kucharska, Pietraszewski y Lesiecki, 2006), or expressed per positions by Karel Hůlka, Roman Cuberek, Jan Bělka (2013).

Table 9. Jumps per game by specific position in basketball.

Jumps per game		
Point guard	Small Forward	Center
15,12 ± 3,89	31,18 ± 7,27	46,30 ± 10,16

So all the work which implemented the jump ability would produce greater improvements in football players, who were less accustomed to the performance of those actions. In any of both groups, injuries associated to the plyometric work weren't produced, the only negative point which should be stand out is the accentuation of the pain in the chronic patellar tendinitis of two basket players who had it chronic, despite doing the adaptations to accomplish the specificity principle and reducing the joint impact in those players. However, they did not lose any session because of that pain and any worsening in their diagnostic was produced.

Conclusions

Improvements are much more important in football group, in all the jumps and in a significant way. The most improved jump is the DJ, in both groups and clearly. There is no improvement in ABK in the basketball group, opposite to the football group, who experiment a very important improvement. With this analysis we do not pretend to compare the intervention itself, which was different and specific for both groups, but just the opposite, to experiment how much utility has a mesocycle with specific work applied to each group and sport and by this way determine the utility of the plyometrics in the real context of the sports training like a method to increase the reactive strength.

The final conclusion, in my opinion, should be that in both groups there are improvements, really great in the football group, less accentuated, but considerable in the basketball group, especially in some players. All of that performed with only 6 weeks of intra-season intervention, with diluid load, competing each week. Because of this, I think it has been demonstrated that the utilization of the plyometrics have positive effects in real practical cases, and not only in researchs with very controlled conditions and choice of researchs subjects. Thereupon, it was achieved to obtain the benefits of the plyometrics exercise in a bigger or smaller degree, and there was not any negative effect as a consequence of this work, like it could be the increase of the injury rate.

I think it is necessary to remark that the weaknesses of this work of practical application, like the fact that only being able to test the ability jump improvements, not to measure the speed improvements and acceleration and deceleration ability, but only to estimate them. For that reason, I think that the ideal situation would be having had photocells and by this way put them in 10, 20 and 30m to measure the acceleration ability, as well as doing the 505 agility test to measure the deceleration and change of direction ability. To be able to measure the improvements in running economy as a result of the plyometric work, would be more complex, but one solution could consist in doing a VO_2 measuring in the lab or with the portable analyzer, like a progressive maximal test in treadmill or in a camp test like the YYIRT 1 (Bangsbo, Iaiá y Krustup, 2008) before and after the intervention, and by this way testing if the players can run more meters without having increased the VO_2 . Other way would be travelling a specific time in a specific % VO_2 previously determined and

compare the meters travelled pre and post-intervention, which could be attributed to the improvements of the neuromuscular characteristics resulting from the mesocycle of plyometric work.

Future research trends could be, I think, the next step to associate the improvements not only with the specific conditional indicators but to the team improvements, if it happens, by this way, getting or at least trying to measure the relationship that could have the plyometric work upon the final team performance.

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