PLYOMETRICS AND THE EFFECT ON FOUR TYPICAL VERTICAL HEIGHT

Mateescu ADRIANA

University of Pitesti, Romania
Faculty of Physical Education and Sport, University of Pitesti, Romania

Abstract

The aim of this study-case was to determine the effects of plyometric training on height of rise, the (maximal) explosive force of legs, the power of the inferior train. The controlled trial that evaluated the effect of plyometric training on four typical vertical height, test were carried out: Counter Movement Jump - CMJ, Continuous Jump with Bent Legs Reference – CJbref, Continuous Jump with Straight Legs - hCJs, Continuous Jump with Bent Legs - CJb30 sec. Study-case was identified by computerised used Bosco Protocol applied Kistler force platform measurement 9290AD Quattro Jump.

The four tests that were performed using Kistler force platform to measure Quatro Jump Bosco Protocol Version 1.0.9.2, gave us the data about the height and jump power and capacity data on neuro-motor recruitment (fast fibers), voluntary effort, fatigue, muscle elasticity effect or stretching.

The pooled estimate of the effect of plyometric training o jump height was plyometric training provides a statistically significant and practically relevant improvement in jump height with the mean effect ranging from 3.8 (CJs) to 7.2 (CJb30s).

Words key: jump height, jump power, explosive strength, fast fibers, plyometrics**.**

Introduction

Plyometric training has been described as exercises or drills that combine speed and strength to produce an explosive movement and an increase in power (Chu, D., 1998).

Plyometrics have been promoted as being specific to almost every sport due to the combination of force and velocity development said Yessis M. in 1991.

Plyometrics are also categorized by their amazing ability to increase reactive strength and jumping skill and coordination.

Plyometrics improve reactive strength by utilizing the Strength-Shortening Cycle (SSC) in order to create maximal power output.

Plyometrics are based on the principle that the SSC can create much more power than a normal muscle contraction because the muscles are able to store the tension from the stretch for a short period of time - causing the muscle to react like a rubber band. The greatest force can be achieved when the stretch is performed as fast as possible.

The key concept to know is that a faster stretched muscle results in greater force development. Lundin, P., Berg, W. (1991, p.25) described the process of plyometrics as:

A muscle forcibly stretched before a contraction uses the stretch reflex to activate the muscle to shorten vigorously, and the elastic nature of the muscle fibers allows the muscle to store energy during negative work, that will be released during the shortening contraction.

It is essential to design training and conditioning programs to be as specific as possible to the actual performance and environment of the activity. Plyometric training is a novel form of conditioning and relates to the specificity principle.

Fox, E.L., Bowers, R.W., Foss, M.L, (1989, p.171) stated: Experience has taught successful coaches that in order to increase the performance of their athletes; a specific training program must be planned for each athlete. In other words, the training program must be relevant to the demands of the event for which the athlete is being trained.

After Radcliffe, J., Farentinos, R., (1985), an effective plyometric program achieves its outcome through the manipulation of four variables: volume, intensity, frequency, and recovery.

Volume relates to the total work performed for each session. Intensity refers to the difficulty and the number of exercises performed in each session. Frequency refers to the number of repetitions that an exercise is performed, and the number of times a session takes place per cycle (week). Recovery is the rest between each set and is a key component in plyometric training. (Robinson, L.E., 2002)

Explosive leg power constitutes a crucial component in numerous athletic events. Vertical jump height demonstrates a positive correlation with lower body power (Potteiger, J.A.,et all 1999). Jumping ability is critical in the execution of many athletic skills, such as high jumping, rebounding and blocking in basketball, and spiking in volleyball. The plyometric training protocol consisted of vertical jumps, bounds, and depth jumps.

Proposal of the study-case

The aim of this study-case was to determine the precise effect of an 8-week of plyometric training on height of rise, explosive force of the legs, power of the lower limb on a college —age male.

The muscular training tests applied: To evaluate data about the height and jump power and capacity data on neuro-motor recruitment (fast fibers), voluntary effort, fatigue, muscle elasticity effect or stretching of the subject studied, the testing method was used by *Bosco Protocol applied Kistler force platform measurement 9290AD Quattro Jump,* thus making use of 4 tests:

The Counter Movement Jump (CMJ) –the test presupposes doing a vertical jump identical to the Squat Jump, but by starting from a standing position. A vigorous flexion is executed, followed by the extension and vertical jump. The differences between the two tests represent the „elastic" aptitudes of the sportsmen. The CMJ performance describes the evaluation of the explosive (maximal) force FV of the legs, and the quality of reusing the muscular elasticity, the capacity of neuro- motric recruit, and the capacity of using the visco-elastic force from the muscular tissue.

The Continuous Jump with Bent legs reference (CJbref) – series of 5 — 7 jumps with bended knees at the contact phase used as reference for cu CJb 15 — 60 seconds. The CJb performance describes the mechanic power of the inferior train.

The Continuous jump with straight legs (CJs) (reactivity test) – series of 5 -10 jumps with stretched knees (short, elastic contact with the ground). The CJs performance describes the evaluation of the muscular elasticity of the legs extension muscles, the jumping technique and tolerance to stretched impact, the quantity of quick fiber.

Continuous with Bent Legs Jump (CJb 30s) - jumps with knees bent at 30 seconds contact phase. CJb describe performance: mechanical power on lower limb and measures alactacide anaerobic capacity.

Organizing and conducting research

The experiment took place at the Physical Education and Sport Faculty, Pitesˌti. Subject under research was a college —aged male. This study was conducted over 8 week and 10 indicators were tested: 3 anthropometric (height, leg length, weight — table 1), 3 physiology (Test Ruffier, standing and supine pulse- table 2) and 4 of movement (*Counter Movement Jump* - hCMJ, *Continuous Jump with Bent Legs Reference – hCJbref, Continuous Jump with Straight Legs - hCJs, Continuous Jump with Bent Legs (hCJb30 sec)* — table 3,4, for thelegs by through which we assess the progress in training and how different methods applied in the preparation.)

Results

Bosco Protocol can evaluate the components: tests explosivitate, plyometric expansion (CMJ) tests the power of the thigh (CJbref), (CJB) reactivity tests (CJs) and measurement alactacide anaerobic capacity (CJb 30s).

Table 1 shows physical characteristics, recorded by an initial and final testing of the student participating in our experiment.

Table 1: Anthropometric tests. ***Somatic growth dynamics of the development indicators initial – final testing***

Name: **M S**						
Age	**Weight (Kg)**		**Waist (cm)**		**Length of legs (cm)**	
	TI 01.04.2011	TF 01.06.2011	TI 01.04.2011	TF 01.06.2011	TI 01.04.2011	TF 01.06.2011
20 ani	77.37 kg	75.45 kg	182 cm	182 cm	100 cm	100 cm

Table 2: Physiological tests. . *Dynamic evolution tests functional indicators initial – final testing*

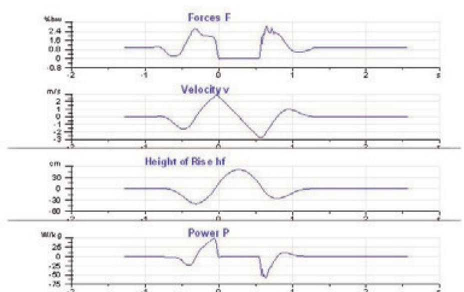
Nr.	NAME	Supine puls beats/minute		Standing puls beats/minute		Ruffier sample points	
		TI	TF	TI	TF	TI	TF
1.	S M	75	70	84	81	8.2	4.7
	df	5		3		3.5	

Table 3: Computer analysis of CMJ

COUNTER MOVEMENT JUMP (CMJ)

INITIAL TESTING

Legend	Leg	hf [cm]	hc [cm]	Pavg [W/kg]	Fi [BW]
3	Both	46.2	-39.7	28.7	1.62
Avg		**46.2**	**-39.7**	**28.7**	**1.62**



FINAL TESTING

Legend	Leg	hf [cm]	hc [cm]	Pavg [W/kg]	Fi [BW]
	Both	49.8	-45.1	28.1	1.63
1					
2	Both	51.7	-45.3	27.7	1.70
3	Both	49.7	-46.1	27.0	1.82
Avg.		**50.4**	**-45.5**	**27.6**	**1.72**
Stdev.		**1.1**	**0.6**	**0.5**	**0.10**

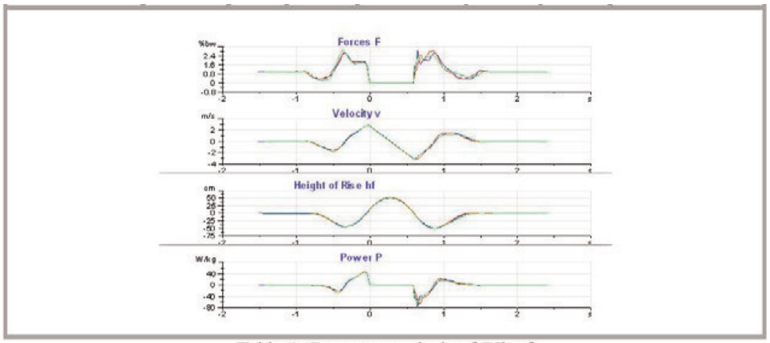
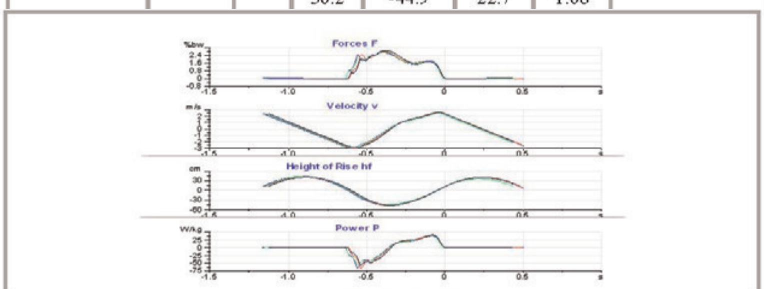


Table 4: Computer analysis of CJbref

CONTINOUS JUMP BENT LEG REFERENCE (CJbref)

INITIAL TESTING

Legend		hf	hc	Pavg	Fi
		[cm]	[cm]	[W/kg]	[BW]
1		40.2	-46.9	23.9	1.64
2		40.7	-47.4	24.4	1.72
		36.2	-44.9	22.7	1.68



FINAL TESTING

Legend		hf	hc	Pavg	Fi
		[cm]	[cm]	[W/kg]	[BW]
1		42.0	-32.5	26.0	1.60
2		42.6	-42.2	26.4	1.79
3		46.7	-39.2	28.5	1.83
4		44.6	-39.4	27.2	1.82
5		44.3	-41.1	26.5	1.76
Avg		**44.0**	**-38.9**	**26.9**	**1.76**
Stdev.		**1.9**	**3.8**	**1.0**	**0.09**

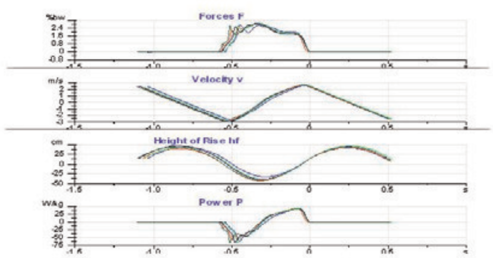
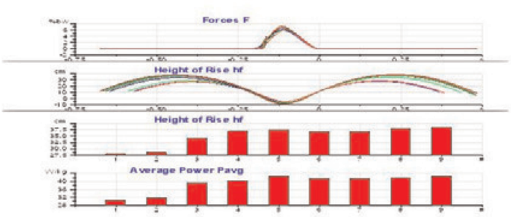


Table 5: Computer analysis of CJs

CONTINOUS JUMP STRAIGHT LEGS (CJs)

INITIAL TESTING

Legend		hf	Pavg	tcont.	k
		[cm]	[W/kg]	[s]	[kN/m]
1		27.9	30.4	0.206	31.50
2		28.6	31.6	0.196	35.21
3		34.2	39.0	0.204	30.03
4		37.0	40.3	0.208	27.96
5		37.4	42.7	0.188	37.49
6		36.6	41.5	0.184	39.85
7		36.8	41.6	0.192	35.19
8		37.8	42.0	0.200	32.51
Avg.		**35.0**	**39.1**	**0.197**	**33.51**
Stdev.		**4.0**	**4.7**	**0.008**	**3.75**



FINAL TESTING					
Legend		hf	Pavg	tcont.	k
		[cm]	[W/kg]	[s]	[kN/m]
1		39.1	39.6	0.228	23.79
2		40.4	43.0	0.218	25.52
3		40.3	43.0	0.214	26.55
4		40.0	43.1	0.214	26.75
5		41.4	43.9	0.216	25.60
6		39.2	43.1	0.212	26.67
7		45.0	44.0	0.260	17.30
8		39.8	43.3	0.190	37.38
Avg		**40.7**	**42.9**	**0.219**	**26.19**
Stdev.		**1.9**	**1.4**	**0.020**	**5.50**

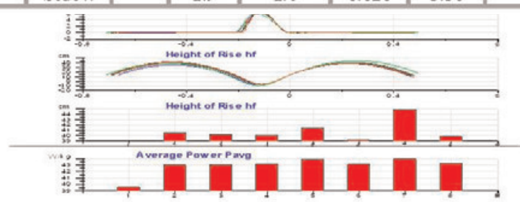
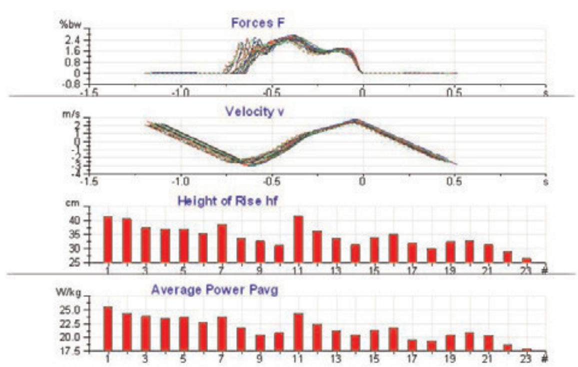


Table 6: Computer analysis of CJb 30s

CONTINOUS JUMP BENT LEGS (CJb30s)

INITIAL TESTING					
Legend	hf	hc	Pavg	Fi	tcont.
	[cm]	[cm]	[W/kg]	[%BW]	[s]
1	41.4	-54.7	25.5	1.75	0.650
2	40.5	-51.5	24.3	1.60	0.670
3	37.5	-52.4	23.9	1.61	0.664
4	37.1	-49.6	23.5	1.55	0.666
5	37.1	-48.0	23.7	1.61	0.656
6	35.3	-46.2	22.7	1.63	0.644
7	38.7	-49.6	23.7	1.56	0.682
8	33.6	-49.8	21.8	1.57	0.674
9	32.7	-49.6	20.4	1.40	0.726
10	31.1	42.8	20.8	1.49	0.684

11	41.7	-52.3	24.3	1.48	0.760
12	36.4	-52.9	22.4	1.57	0.712
13	33.7	-48.7	21.2	1.41	0.700
14	31.4	-47.7	20.3	1.47	0.696
15	34.0	-49.0	21.3	1.50	0.716
16	35.1	-50.3	21.8	1.52	0.716
17	31.9	-51.7	19.5	1.38	0.754
18	30.0	-50.9	19.4	1.47	0.742
19	32.6	-52.3	20.4	1.42	0.776
20	32.8	-52.6	20.8	1.44	0.756
21	31.4	-52.7	20.3	1.51	0.756
22	29.0	-52.2	18.7	1.43	0.780
23	26.5	-45.9	17.9	1.42	0.786
Avg.	**34.4**	**-50.1**	**21.7**	**1.51**	**0.712**
Stdev.	**4.0**	**2.8**	**2.0**	**0.09**	**0.045**



FINAL TESTING

Legend	hf	hc	Pavg	Fi	tcont.
	[cm]	[cm]	[W/kg]	[%BW]	[s]
1	42.4	-37.5	26.1	1.72	0.554
2	38.4	-39.4	23.8	1.72	0.590
3	44.3	-40.6	26.4	1.77	0.596
4	44.2	-41.3	26.6	1.74	0.584

	5	43.7	-39.5	26.4	1.73	0.568	
	6	42.2	-39.1	26.1	1.78	0.566	
	7	41.8	-38.8	25.3	1.63	0.598	
	8	40.6	-38.0	24.8	1.66	0.590	
	9	38.0	-34.9	23.8	1.52	0.580	
	10	38.2	-37.4	24.0	1.69	0.592	
	11	42.1	-35.6	25.8	1.64	0.576	
	12	34.9	-33.3	23.1	1.71	0.570	
	13	43.8	-41.3	26.1	1.70	0.650	
	14	38.9	-39.3	23.6	1.63	0.620	
	15	34.8	-37.2	22.2	1.63	0.596	
	16	40.3	-44.8	24.4	1.75	0.658	
	17	37.9	-40.1	23.6	1.66	0.612	
	18	37.2	-42.4	22.5	1.56	0.660	
	19	33.2	-38.8	21.5	1.66	0.634	
	20	38.4	-47.8	22.8	1.71	0.698	
	21	34.9	-46.2	21.5	1.63	0.670	
	22	34.8	-43.2	21.8	1.64	0.650	
	23	29.2	-45.6	19.1	1.62	0.692	
	24	32.2	-40.6	20.6	1.65	0.670	
	25	34.7	-44.6	20.8	1.47	0.722	
	Avg	**38.4**	**-40.3**	**23.7**	**1.66**	**0.620**	
	Stdev.	**4.1**	**3.6**	**2.1**	**0.07**	**0.047**	

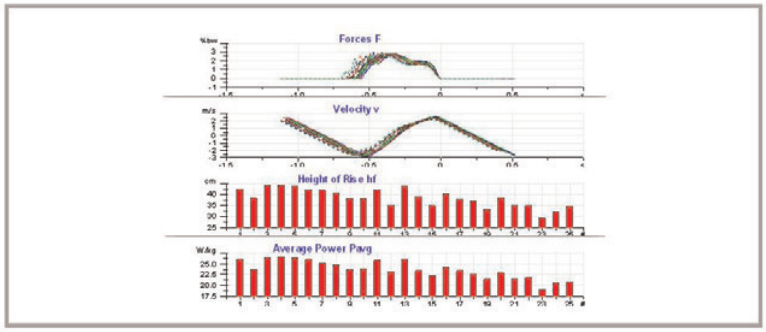


Figure below shows the best height of rise registered

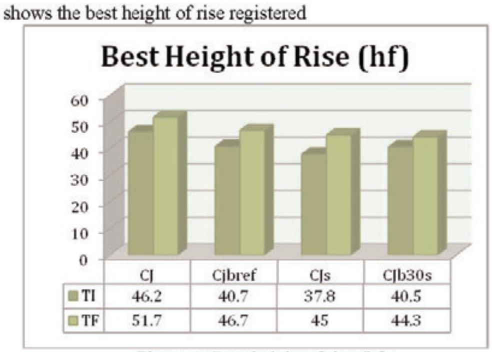


Figure 1: Best height of rise (hf)

Discussion

The height of the *Counter Movement Jump* (CMJ) (jump against movement) determines a significant change, with a difference of 5,5 (pre = 46,2, post = 51,7).

The height of the *Continuous Jump with Bent Legs Reference (CJbref*) (continuous jump with bent legs reference)- shows a significant difference of 6,0 (pre = 40,7, post = 46,7).

The height of the *Continuous Jump with Straight Legs (CJs)* **(**continuous jump with straight legs)- determines a significant change, with a difference of 7,2 (pre = 37,4, post = 45,0).

The height of the *Continuous Jump with Bent Legs (CJb30 sec)* (continuous jump with bent legs 30sec)- shows a significant difference of 3,8 (pre = 34,4, post = 38,4). Other data are presented in the tables above.

Conclusions

Maximum muscle strength under explosive momentum, benefits from a high capacity to reuse elastic energy of muscle, with a coordination component of the viscous-elastic movement.

The final testing we can speak of an improvement in all indicators covering both the height and power. Maximum explosive power indicator on an elk, has improved and we can say that the benefits from a high capacity to reuse elastic energy of muscle, with a coordination component of the viscous-elastic movement.

In conclusion, the present study demonstrates that plyometric training significantly improves height of rise, explosive force of the legs, and power of the lower limb in all four types of standard vertical jumps. The observed mean effect in jump height ranged between 3.8% and 7.2% and could also be considered as practically relevant.

References

1. Adams, K., O'Shea, J.P. O'Shea,K.L., Climstein, M., (1992), The effects of six weeks of squat, plyometrics, and squat plyometric training on power production. J. Appl. Sports Sci. Res. 6:36-41
2. Chu, D., (1998), Jumping into plyometrics. Champaign, IL: Human Kinetics, 1998
3. Fox, E.L., Bowers, R.W., Foss, M.L, (1989), The physiological basis of physical education and athletics. Dubuque, IA: Brown
4. Lundin, P., Berg, W., (1991), A review of plyometric training. Nat. Strength Cond. Assoc. J. 13:22-30.
5. Radcliffe, J., Farentinos, R., (1985), Plyometrics — explosive power training. Champaign, IL: Human Kinetics
6. Yessis, M., (1991), Speed/explosiveness with plyometrics. Scholastic Coach 60:32-34.
7. Niculescu M., Mateescu A., Cretu M., Traila H.,(2007) - The scientific bases of training and applied muscle, Publisher Universitaria Craiova

8. Potteiger, J.A., Lockwood,R.H., Haub,M.D., Dolezal, B.A., Alumzaini,K.S., Schroeder, J.M., Zebas, C.J. (1999), Muscle power and fiber characteristic following 8 weeks of plyometric training. J. Strength Cond. Res. 13:275-279

9. Robinson, L.E., (2002), The effects of land versus aquatic plyometrics on power, torque, velocity, and muscle sorenss, Thesis, Ohio State University