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THE IMPACT OF PLYOMETRICS AND AQUA PLYOMETRICS ON THE LOWER EXTREMITIES EXPLOSIVE STRENGTH IN CHILDREN AGED 11-15

(Original scientific paper)

Andrija Atanasković, Martin Georgiev and Vladimir Mutavdzić
Universitiy of Niš, Faculty of Sport and Physical Education, Niš, Serbia

Abstract

Very often, because of its intensity and nature plyometric training can lead to injuries. The very structure of a plyometric training is such that it requires the adaptation of muscle from an eccentric to a concentric contraction. Aqua plyometric training has recently become more popular due to a significantly lower probability of injury. The aim of this study is to compare and determine the effect of the aqua plyometric training on the leg explosive strength as compared to the conventional plyometric training. This survey was administered to thirty participants, divided into three groups. The control group (K) was regularly attending physical education classes, group (P) included plyometric training on dry ground, group (AP) included plyometric training in 1.30 cm deep water. Using Myotest and the execution of the half squat jump (SMJ) and squat jump (SJ) following variables were identified: Height, Power, Force, and Velocity. Plyometric training lasted for six weeks, with two 50-60 minutes sessions per week. During a six-week program of plyometric and aqua-plyometric testes we reached the conclusion that both programs have a positive effect on the lower extremities explosive power, but there is no significant difference between the groups involved in an exercise program in the final measurement.

Keywords: *control group, experimental group, Myotest, jump squat, half squat jump, initial measurement, final measurement.*

INTRODUCTION

Many studies have confirmed that plyometric training increases the lower extremities explosive power (Marković, 2007; Fatouros, Jamutras, Leontsini, Taxildaris, Aggeolusis 2000; Ronnestad, Kvamme, Sunde, & Raastad 2008). Very often, because of its intensity and nature plyometric training may lead to injuries. The very structure of plyometric training is such that it requires the adaptation of the muscle from an eccentric to a concentric contraction (Baechle, 1994). When the muscles are stretched during eccentric contractions, they lack elastic energy, this energy, accompanied by a rapid concentric contraction, produces more power from an independent concentric contraction (Miller, Cheatham, Porter, Ricard, Hennigar 2007). Plyometric training is very popular because it provides exercising the lower extremities mainly by using one's own body weight, and in the upper limbs throwing a medicine. Plyometric training, in addition to increasing the explosive power, can be used as a training to increase anaerobic endurance (Marković & Mikulic, 2010). The general definition of plyometric training is that it is a procedure of high intensity allowing muscles to produce what is more effective in a short period of time (Radcliffe & Farentinos, 1999). Aqua training of the plyometric training is not a new concept, but lately it has been gaining in ~~is~~ popularity, primarily due to a significantly lower probability of injury and load reduction on the joints that occur as amortization (Miller, Berry, Bullard, & Gilders, 2002). Earlier, the training in water was for the purpose of rehabilitation, and today, because of the high water density and greater resistance, training in water becomes an integral part of fitness preparation. Any movement in water requires an extra effort and muscle activation. Miller et al. 2007, examined the impact of the aqua plyometric training in different depths, lasting up to 4 weeks until there was an increase in the plyometric group 3.1% and 4.9% in the control, and in both $p < 0.005$. From 4th to 6th week~~s~~ there was a further increase of 8% in the plyometric group, and -0.9 % in the control group. Stemm & Jacobson (2007) compared the training of plyometrics in water with the training plyometric on dry. There was a statistically significant change in both grupes p<0.005, but no difference was found between the plyometric program on dry and in water.

The aim of this study is to compare and determine the effect of aqua plyometric training on leg explosive strength as compared to the conventional plyometric training. All explosive strength variables were measured by a Myotest machine, an accelerometer that automatically calculates the mean value.

METHODS

Subjects

This study was conducted comprising 30 male subjects, mean age 12.90 ± 1.55 (Mean ± St.Dev.), mean body weight of 59.34 ± 13:30 (Mean ± St.Dev.) expressed in kg, mean body height 167.90 ± 9.78 (Mean ± St.Dev.) expressed in cm. The subjects were divided into three groups; each group was composed of ten subjects. The first group was a control group (K), which regularly attended basketball, trainings, the second group (P) included plyometric training on dry, the third group (AP), which performed plyometric training in water, depth of 1.30 cm. All subjects involved in training process were completely healthy, without any hidden injuries.

Variables

Using the Myotest and the execution of the half squat jump (CMJ) and squat jump (SJ) following variables were identified:

(CMJ)
1 HeightC (height in cm),
2 PowerC (power expressed in W/kg),
3 ForceC (force expressed in N/kg),
4 VelocityC (acceleration expressed in cm/s).
(SJ)
1 HeightS (height in cm),
2 PowerS (power expressed in W/kg),
3 ForceS (force expressed in N/kg),
4 VelocityS (acceleration expressed in cm/s).

The measurement was performed by Myotest. The performance of CMJ and SJ was demonstrated to the subjects. Each of the subjects performed 5 CMJ and SJ jumps and the accelerometer calculated mean values.

Training protocol

Plyometric training lasted for six weeks, with two 50-60 minutes sessions per week. The introductory part of the training consisted of a fifteen-minute warm-up, high- and low- skip, jumps, squats. The plyometric program was composed of four exercises: jump from the ankle (ankle hoops), jump from a crouch (squat jumps), the half squat jumps (jumps countemovement), lateral Jumps (lateral jumps). The total number of jumps in the training ranged from 90 to 160, the pause between the series was one minute, a break between exercises was three minutes (Miller et al. 2007). The water temperature was from 23° to 25°.

Data Processing

To determine the intergroup differences in the initial and final measurements between the groups, a multivariate analysis of variance MANOVA, was used.

RESULTS AND DISCUSSION

Table 2 shows the mean values of variables tested in all groups, at the initial and final measurements. Results P and AP are very similar so that the multivariate level differences are almost non-existent.

Table 3 shows that there were no statistically significant differences between the groups in the initial F= 1.214; sig = 0.299

Table 4 shows the difference between K vs AP group (F = 12.040, sig = 0.000) and K vs P (F = 8.363, sig = 0.001), which shows that the program of plyometric and aqua-plyometric led to an improvement in the monitored variables- whereas between P vs AP the difference is not statistically significant (F = 2.363, sig = 0.949).

Table 5 shows that there are statistically significant

Table 1. Program of plyometric training

Sunday	Tuesday	Saturday
1	ankle hoops 2x15; SJ 2x10x40 CMJ 2x10x40;lateral jumps 2x10x40	ankle hoops 2x20x; SJ 2x15x40 CMJ 2x15x40; lateral jumps 2x15x40
2	ankle hoops 3x15; SJ 3x10x40 CMJ 3x10x40; lateral jumps 3x10x40	ankle hoops 3x20; SJ 3x15x40 CMJ 3x15x40; lateral jumps 3x15x40
3	ankle hoops 2x15; SJ 2x10x50 CMJ 2x10x50; lateral jumps 2x10x50	ankle hoops 2x20; SJ 2x15x50 CMJ 2x15x50; lateral jumps 2x15x50
4	ankle hoops 3x15; SJ 3x10x50 CMJ 3x10x50; lateral jumps 3x10x50	ankle hoops 3x20; SJ 3x15x50 CMJ 3x15x50; lateral jumps 3x15x50
5	ankle hoops 2x15; SJ 2x10x60 CMJ 2x10x60; lateral jumps 2x10x60	ankle hoops 2x20; SJ 2x15x60 CMJ 2x15x60; lateral jumps 2x15x60
6	ankle hoops 3x15; SJ 3x10x60 CMJ 3x10x60; lateral jumps 3x10x60	ankle hoops 3x20; SJ 3x15x60; CMJ 3x15x60; lateral jumps 3x15x60

Number series x number repetition x height of platforme

Table 2. Mean values of the initial and final measurements

Variable	K- group		P- group		AP- group	
	Initiall	Final	Initiall	Final	Initiall	Final
HeightS	23.85	*24.03*	22.61	*30.16*	27.37	*31.21*
ForceS	25.24	*25.33*	23.36	*34.75*	25.49	*30.81*
PowerS	42.36	*42.44*	36.81	*48.04*	47.79	*52.90*
VelocityS	220.10	*220.90*	206.40	*232.70*	248.60	*265.50*
HeightC	26.44	*26.61*	26.27	*32.99*	29.76	*35.75*
ForceC	26.49	*26.83*	25.88	*32.99*	22.87	*32.81*
PowerC	39.78	*39.61*	37.75	*36.73*	37.54	*46.69*
VelocityC	208.50	*208.60*	198.00	*217.40*	207.00	*231.40*

Table 3. Differences between the groups in the initial measurement

Effect	Value	F	Df1	Df2	Sig.
Wilks‘ Lambda	.453	1.214[a]	16.0	40.0	.299

Table 4. Intergroup differences in the final measurement at the multivariate level

Effect		Value	F	Df1	Df2	Sig.
K vs AP	Wilks‘ Lambda	.103	12.040[a]	8.0	11.0	.000
K vs P	Wilks‘ Lambda	.141	8.363[a]	8.0	11.0	.001
P vs AP	Wilks‘ Lambda	.368	2.363[a]	8.0	11.0	.094

K vs AP differences between the control and aqua plyometric group; K vs P-differences between the control and plyometrics group; P vs AP-difference between the plyometric and aqua-plyometric group.

Table 5. Intergroup differences in final measurements at the univariate level

Dependent Variable	*F-value*			*Sig. (relevance)*		
HeightS	18.57	*8.74*	.47	.000	.005	.499
ForceS	8.43	*73.07*	4.49	.009	.000	.048
PowerS	11.56	*2.19*	1.89	.003	.155	.186
VelocityS	32.67	*1.16*	13.17	.000	.005	.002
HeightC	12.89	*4.25*	1.12	.002	.004	.302
ForceC	10.07	*6.84*	1.27	.005	.005	.273
PowerC	3.29	*2.20*	.05	.086	.155	.813
VelocityC	3.39	*.67*	1.19	.082	.002	.289
Differences between groups	*KvsAP*	*KvsP*	*PvsAP*	*KvsAP*	*KvsP*	*PvsAP*

differences in most variables where the sig <0.005 except at K vs AP (Powercom, sig = 0.086; VelocityC, sig = 0.082) and K vs P group (Powers, sig = 0.155; Powercore, sig = 0.155), and between the AP P vs group there is a difference only in VelocityS (sig = 0.002), while in all other variables sig> 0005.

After completing a six week plyometric program a conclusion can be reached that regardless of the natural environment, plyometric program leads to a positive outcome. Robinson Devor, Merrick & Buckworth (2004) examined the impact of the aquaculture on a plyometric explosive strength, claiming sensitivity to pain is reduced sig < 0.001 (Shiran, Cordoba, Ziaei, Ravasi & Mansournia, 2008), while other variables significantly increased in both groups sig < 0001, and in the current research in the group P (sig = 0.004) and in the AP - group (sig = 0.001), showing no difference between groups. Ploeg, Miller, Holcomb, O'Donoghue, Berry in 2010 found that there was no statistically significant difference between the groups at in the final measurement, but the group with higher intensity program showed the largest increase in all measured variables. Shiran et al., (2008) in his research came to a conclusion that there was no statistically significant difference between the plyometric programs that were conducted in different environments. The only difference is considerably less damage and muscle aches with plyometric program which was carried out in water. Robinson et al., (2002) concluded that the force, acceleration and torque were improved sig = 0.001 versus VelocityS (sig = 0.000 in the AP and sig = 0.005 at P). There were no differences between the groups that participated in the treatment, but there was a difference in the very sensitivity of muscle pain, sig < 0.001. Arazi, Coetzee & Asadi (2012) concluded that training plyometrics leads to an increase in jump height of 13cm versus (ΔHightS = 7.55 cm ; ΔHightC = 6.72 cm), while the aqua - plyometric training increases jump height 13.5 cm versus (ΔHightS = 7, 84cm; ΔHightC = 6cm). A smaller increase in jump height can be explained by the short program of training and older subjects, and thus higher intensity and better techniques of exercise.

CONCLUSION

Comparing sixweek program plyometric, aqua-plyometric a conclusion can be reached that both programs have a positive effect on the lower extremities explosive power P, sig = 0.004; AP, sig = 0.001; but there were no significant differences between the program sig = 0.94. With the aqua plyometric program there were no significant changes in the acceleration of the final measurement, compared to the control group VelocityC, sig = 0.082. This may be justified by the higher density of water, hence the slower performance of movement, especially in the eccentric - concentric rebounds in CMJ. Muscle aches were not the subject of this study, but based on the results (Robinson, Devor, Merrick, & Buckworth 2002; Miller et al., 2007), it can be concluded that the aqua plyometric program significantly reduces the chance of injury and damage to the muscles. It is necessary to make a number of studies within this field, especially as aqua plyometrics is relatively a new training procedures, and leads to the identical results as plyometric training with a much smaller number of injuries.

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Correspondence:
Vladimir Mutavdzić
University of Niš
Faculty of Sport and Physical Education,
10a Čarnojevića, 18000 Niš, Serbia
E-mail: muta61@open.telekom.rs