Research Journal of Biological Sciences 3 (5): 457-461, 2008
ISSN: 1815-8846

The Effect of Aquatic and Land Plyometric Training on Physical Performance and Muscular Enzymes in Male Wrestlers

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Abstract: The purpose of this investigation was to compare Aquatic and Land plyometric training on performance and muscular injury in club wrestlers. For this reason 21 club wrestlers were selected voluntary and divided to two exprimental groups (Land plyometric training (n = 7) Aquatic plyometric training (n= 7)) and control group (n = 7) randomly. The mean (standard deviation) of age was 20.3 (3.6), height 169 (5.3), weight 65.3 (8.8). Exprimental groups trained four main skills of plyometric training including depth, star, rocket and squat jumps for five weeks and 3 times per week and 40 to 45 min in per session and control groups had their routine training. For determination the effects of plyometric training were measured strength, speed, agility, Fatigue index, peak and mean power and to evaluate Pathogenesis of these training inflammatory enzymes including CK, LDH were measured. The analyzing of data by ANOVA and T test showed: There was no significant difference between 2 model of plyometric training (Aquatic and Land) in performance and risk of muscle injury in male club wrestlers. Aquatic plyometrics provided the same performance enhancement benefits as land plyometrics with less muscle soreness.

Key words: Aquatic plyometric, land plyometric, performance, muscular injury, wrestler

INTRODUCTION

The use of various types of exercises in champion sports is occasionally associated with complications that contradict the main goal of physical activity, which is maintaining human health. In order to eliminate or reduce the harmful effects of heavy exercises in champion sports and to achieve highly efficient exercises, researchers in the exercise science have been always looking forward to finding new methods to benefit the advantages and mitigate the risks of this kind of exercises.

In the 1960s, researchers developed a new type of exercise that was initially called shock exercises and was later renamed to plyometric exercises.

These exercises cause great changes in fitness through stretch-reflex mechanism (a forceful contraction after the muscle stretched), so that most experts of exercise science view them as the highly efficient component of exercises to induce functional changes (Matavulj *et al*., 2001).

In the majority of sports maximum strength and maximum speed, that are the principles of fitness, may be increased using plyometrics (Matavulj *et al*., 2001). However, these exercises can cause injury in various parts like vertebrae and osteoarticular units as well as acute muscular soreness (Grantham, 2006; Miller *et al*., 2001). This has led researchers to change the format and structure of plyometrics. Some have investigated the effect of different surfaces like sand and wood or use of special footwear in reducing injuries (Miyama and Nosaka, 2004; Sova, 1998). Others have recommended that these exercises be done on safer environments like a pool.

Water may reduce the pressure put on the musculoskeletal system because of the resistance it shows at the time of entry and rapid changes of direction (Robinson *et al*., 2004; Sova, 1998).

Different studies that have compared the complications of aquatic and land plyometrics show that aquatic plyometric exercises are associated with fewer complications and similar functional changes (Martel *et al*., 2005; Robinson *et al*., 2004).

The number of researches comparing effect of aquatic and land plyometric traning with a focus on traumatogenic effects is very small and mostly includes female

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participants. There has been no research in this regard comprising male participants and especially, professional wrestlers (Martel *et al.*, 2005; Robinson *et al.*, 2004).

Considering the paucity of research in this regard, we designed a study to compare aquatic and land plyometrics in terms of performance improvement and injuries in male wrestlers.

MATERIALS AND METHODS

This was a semi-experimental study to compare aquatic and land plyometrics in 2006. Participants were male wrestlers with a minimum of 4 years of continuous practice. The inclusion criteria, as defined by American Association of Power and Bodybuilding, included the ability to move a weight equal to 1.5-2 times the body weight of the participant in a back squat exercise. Twenty-one volunteer wrestlers were randomly assigned to three of aquatic exercises, land exercises and control groups (7 participants in each group). Written consent was obtained from all participants.

After selection, the record of participants was registered in a training session to determine their maximum power in doing plyometric exercises. The training program included 4 types of plyometric exercises that are executable in water and land.

These were depth jump, star jump, squat jump and rocket jump. The intensity and content of each training session was determined by calculating a combination of the four mentioned jumps and applied with a gradual increment in each session.

The intensity of training was variable and determined according to the Table 1. The total training schedule consisted of 16 sessions (3 times weekly) and each session lasted 55 min. Every session started with a 15-min warm-up and finished with 5 min of stretch movements to cool down. Exercises were done in sets of 30 repetitions with 30-45 sec rest between the sets and 2 min rest between each jump.

Each session comprised four selected jumps at equal times. Pre test and post test evaluations included measurement of LDH, CPK and functional tests. The blood levels of the muscle enzymes were compared among the three groups using ANOVA test to identify the pressure exerted on the musculoskeletal system by the exercises and compared between two groups by independent T test.

Table 1: The intensity of training in different training session

Sessions	Intensity of training (%)
1-2	80
3-5	85
6-8	90
9-11	95
12-14	100
15-16	105

The efficacy of these two training methods was assessed and compared by measuring functional parameters like, power (rast test), speed (5, 10, 20 test), maximum strength (back squat exercise), agility (4×9) and fatigue index. Functional parameters and were compared between two groups by independent T test. Statistical analysis was done using SPSS (version 13) and the significance level was assumed 0.05.

RESULTS

Participants were male wrestlers with an average (standard deviation) age of 20.3 (3.6), height 169 (5.3), weight 65.3 (8.8). Table 2 summarizes the demographic data of the three groups. In the pre test phase, there was no significant difference among the participants regarding functional and physiologic parameters. Table 3 shows the means of functional parameters of the participants in the aquatic and land group in pre and pos test phase. Strength increases in both groups significantly and speed (20-meter) increase in landing group significantly, but other parameters did not have any significant changes in both groups.

The means of changes in functional parameters of the participants in the aquatic and land group (pre and pos test phase) are compared in Table 4. A comparison of two groups showed that training method had effect on the records of speed (20 m) in land training group. There were not significant effects on other parameters in both groups. Despite a slight increase in average fatigue index in two groups, aquatic and land plyometrics did not influence this index significantly and no meaningful difference was noted between the experimental groups.

Table 5 shows distribution of mean levels of inflammatory enzymes CPK and LDH in pre and post test phases of study. CPK was increased in both groups after implementation of the training protocol. This increase was critical in the land plyometrics group (191 IU) and almost approached a statistically significant level.

The effect of plyometric exercises on blood levels of CPK was not significant different in the aquatic and control groups, but the changes in this parameter increased significantly in land training group. LDH levels were reduced in all three groups, but this reduction was not significant, statistically. The mean of changes of muscle enzymes in each group was compared with another group in Table 6. CPK increased in land training group in comparison to control group, significantly.

Table 2: Physical characteristics and age of participants of experiment and control groups

Parameter	No	Body massindex (kg.m^2)	Age (year)	Weight (kg)	Height (cm)
Water group	7	22.2 (2.4)	18 (4.1)	63 (3.3)	170 (3.9)
Land group	7	23.4 (1.8)	21 (9.5)	65 (9.5I	167 (6.6)
Control group	7	23.7 (1.6)	22 (3.1)	70 (8.6)	170 (5.5)

Table 3: Distribution of the means of functional parameters of the participants in the aquatic and land group in pre and pos test phase

Functional parameters	Groups	Pre test	Post test	P value
Strength (kg)	Water training	118±17.2	129±25.7	0.03
	Land training	131±14.2	147±19.5	0.005
Speed 5 meter	Water training	1.07±8.4	1.13±9.4	0.3
	Land training	1.13±0.1	1.14±9	0.8
Speed 10 meter	Water training	1.68±0.4	1.57±0.3	0.07
	Land training	1.83±0.2	1.78±0.3	0.5
Speed 20 meter	Water training	3.46±0.2	3.44±0.1	0.6
	Land training	3.5±0.2	3.37±0.2	0.006
Agility (second)	Water training	9.39±0.5	9.31±0.4	0.4
	Land training	9.7±0.4	9.6±0.3	0.3
Power	Water training	396±65.9	407±63.6	0.2
	Land training	428±100.4	430±84.8	0.7
Maximum power	Water training	417±68.2	427±66.1	0.1
	Land training	453±106.7	459±92.6	0.4
Fatigue index	Water training	1.2±0.3	1.24±0.6	0.8
	Land training	1.42±0.3	1.49±0.4	0.6

Table 4: The functional parameters of the participants in the aquatic and land group in pre and pos test phase

Functional parameters	Difference in water training group	Difference in land training group	P-value
Strength(kg)	11.3 (3.8)	16.4 (3.9)	0.3
Speed 5 meter	0.06 (0.05)	0.009 (0.05)	0.5
Speed 10 meter	-0.11 (0.05)	-0.5 (0.06)	0.4
Speed 20 meter	-0.03 (0.04)	-0.13 (0.03)	0.09
Agility (second)	-0.08 (0.08)	-0.11 (0.09)	0.8
Power	10.6 (7.3)	2.5 (7.6)	0.4
Maximum power	10.0 (5.5)	6.0 (6.5)	0.6
Fatigue index	0.04 (0.16)	0.07 (0.13)	0.9

Table 5: Distribution of mean levels of inflammatory enzyme in the study groups in pre and post test phases

		Water training group	Land training group	Group control	P-value
CPK (IU)	Pre test	271.0 (27.9)	238.0 (13.8)	236.0 (47.7)	0.1
	Post test	342.3 (166.7)	429.3 (163.5)	251.0 (67.8)	0.4
	P.value	0.3	0.02	0.6	
LDH (IU)	Pre test	524.0 (179.6)	453.0 (170.1)	348.7 (59.5)	0.7
	Post test	381.5 (67.0)	374.2 (70.6)	345.3 (39.7)	0.9
	P.value	0.3	0.2	0.9	

Table 6: The comparison between changes of muscle enzymes in all groups with each other

Groups	CPK	P-value	LDH	P-value
Water training group	71.3 (64.9)	0.4	-142 (110.2)	0.08
Control group	15.0 (27.0)		-3.4 (28.9)	
Land training group	191.3 (62.3)	0.02	-78.7 (49.9)	0.2
Control group	15.0 (27.0)		-3.4 (28.9)	
Water training group	71.3 (64.9)	0.2	-142 (110.2)	0.4
Land training group	191.3 (62.3)		-78.7 (49.9)	

DISCUSSION

Improvement in functional parameters of speed, strength, agility and power was observed in both groups in the pos test phase; however, this improvement was significant only for strength and speed (20 m) in land training group and the exercises had no effect on fatigue index.

The power of participants improved slightly and they enjoyed a better status in the post test phase. This reflects a simultaneous recruitment of motor units and firing rate of muscular fibers in the participants of both groups. The slight improvement in the power of participants can be attributed to their relative fitness before the study. The evaluation of mean and maximum power showed no significant difference between two groups; this is similar to findings of Rrobinson *et al*. (2004) and Martel *et al*. (2005) and Stemm and Jacobson (2005), although power (measured by vertical jump) has been improved in in Wilson *et al*. (2004) and Harmer *et al*. (2002) studies, Shaffer (2007).

There was no significant difference in speed and agility between aquatic and land exercise groups. The average times recorded for 5, 10 and 20 m runs showed a slight numerical improvement in 10 and 20 m runs, but speed 20 m had significant changes in land training group. Robinson *et al*. (2004) and Grantham (2006) also observed a little increase in speed records and no difference in speed and agility of participants in both groups; these are completely compatible with the results of the current study.

Some of the elements of physical fitness, like speed, flexibility and agility are largely influenced by unknown factors including inherited factors; this explains the scant effects of environmental factors like a training schedule.

The participants of both groups achieved a significant increase in maximum muscular strength compared to pre test phase. It seems aquatic and land plyometrics cause a tangible increase in the recruitment of motor units of agonist muscles and hence, improve the strength of the participants.

This may point to the greater effect of plyometrics on strength of males. However, there was no significant difference between 2 groups. These findings are similar to those reported by Miyama and Nosaka (2004) and Robinson *et al*. (2004).

The fatigue index has been less addressed by researches about plyometrics. Neither of the training methods studied in this research improved the fatigue index and there was no difference between them in this regard. It should be noted that the less the fatigue index is the better is the athlete's condition. The fatigue index, measured by rest test, is calculated by dividing the difference between minimum and maximum power by the sum of time elapsed during the test. A constant value of this index is related to a decrease in the difference between minimum and maximum power after the test because the average time was also decreased in pre and posttest phases.

$$\text{FI} = \frac{\text{Maximum power} - \text{Minimum power}}{\text{Total time elapsed in 6 reps}}$$

Although the level of CPK was increased in all three groups, this increase was significant in the land group. In addition, the changes of CPK level was significant in land training group compared with 71 IU in control group (191 IU in compared with 15 IU). Quantitative analysis of this enzyme showed that aquatic plyometrics were efficient in reducing the pressure exerted on the musculoskeletal system; as also reported by Martel *et al*. (2005), Robinson *et al*. (2004) and Miyama and Nosaka (2004) (71IU). Nevertheless, further research is required to prove aquatic plyometrics as a safe training model. In a research on the levels of CPK, Martel *et al*. (2005), Robinson *et al*. (2004), Miyama and Nosaka (2004), Shaffer (2007) demonstrated that aquatic plyometrics are safer; a finding that is in contradiction with our results. Considering the marked difference in the levels of CPK between 2 groups, it seems that if the number of participants and the duration of the training increased, the difference would become significant. Prior research has mainly dealt with women who are more vulnerable to injury secondary to training pressure.

In order to investigate the pressure of training more closely, levels of LDH were also measured. Serum levels of LDH did not increase in any of the groups, rather it decreased in all groups in a non-significant manner. These exercises had no effect on the level of LDH enzyme, as a marker of muscular injury. This is similar to findings of Martel *et al*. (2005) and Robinson *et al*. (2004). The decrease observed in the level of LDH can be explained by the role of subsidiary exercises and unknown factors like, nutrition and physiological fluctuations that were not controlled during the research and constitute a part of the limitations of this study.

Sumida *et al*. (1995), Bloor and Papadopoulos (1969), Podolin *et al*. (1994) and Greenleaf *et al*. (1985) observed the effects of endurance exercises in lowering the levels of LDH. Since endurance and its related exercises, is a requisite for fitness in wrestling, the participants of the current research have probably used such exercises, this may contribute to the reduction observed in the level of LDH as suggested by these researchers.

CONCLUSION

In conclusion, there was not any significant different between aquatic and landing plyometric training performance except in speed, but land plyometrics was accompanied with a significantly increase in CPK enzyme, that is probably due to muscle soreness. Therefore, aquatic plyometrics is practical training option to enhance performance in athletes while reducing muscle soreness.

ACKNOWLEDGEMENT

This study has been supported by Sports Medicine Research Center, Tehran University of Medical Sciencest. We are grateful to the wrestlers who participate in this study.

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