Effect of plyometric exercise in water and grass on indicators of protein catabolism, muscle damage and muscle inflammation

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ABSTRACT :

the purpose of the present study was to compare protein catabolism indicator (blood urea nitrogen [BUN]), muscle damage indicators (lactate dehydrogenase (LDH) and myoglobin (Mb)) and inflammation indicator (interleukin (IL6)) after a single plyometric exercise (PE) session performed in water and on grass . Fifteen healthy and physically active male third year students at the faculty of physical education for boys, with a mean age of 20.62 ±.59 years, a height of173.8 ± 4.95 cm, and a body mass of 72.67 ± 8.27 kg participated in this study . the result showed that there are statistically significant differences between aquatic and Grass group measurements in all variables of the research except LDH . The present study can recommend that coaches and strength & conditioning professionals use Aquatic Plyometric or safe surfaces like a firm surface for plyometric training to decrease muscle damage.

INTRODUCTION

Plyometric training is a form of muscle power training (speed - strength) and has many important benefits, including progression of vertical jump (VJ) , strength [1,26], speed [3,26], agility [3], balance [2]. However it can also lead to damage and swelling and pain in the muscles, which may cause a decrease in muscle strength [19,30] ,muscle power [3,8] and a lack of range of motor joints (Range of motion) [8,24] and may cause injuries in the muscle structure, especially in the lower limb [27].

 During plyometric exercise , such as Squat jump, Tuck jump, Power skipping, Alternate leg bounding, Box jumps, etc., the stretch-shortening cycle (SSC) especially during landing plays an important role in improving strength, power, speed, core stability, balance, joint function , and neuromuscular control [10,20]. The SSC cycle consists of three phases a rapid eccentric muscle contraction phase,an amortization phase followed by a rapid concentric contraction phase in the same agonist muscles [14]. This rapid combination between eccentric and concentric contraction prepare a physiological benefits in muscular power development during the concentric phase [1].The amortization phase or "time to rebound" is the most important phase in plyometric activity which depends on stretch reflex and this phase is crucial in developing power production [13].However, some of studies showed that eccentric contractions involved in plyometrics exercise cause muscle damage and inflammation [2,30].Moreover, plyometric exercise (PE) on the solid surfaces frequently cause muscle damage in the knee extensors [17,30] .

However , plyometric training in water probably present an optimal load with less muscle damage, many studies have indicated that damage indicators are lower after aquatic plyometric training in comparison with plyometric training on land [11,20,21,25,26,29] . Furthermore, Studies of Aquatic plyometric training showed statistically significant improvements in vertical jump, speed, agility and muscular strength [21,23,28,29].

Monitoring of the muscle damage indicators plays an important role in controlling the physiological and training status of athletes, however adaptation of the muscular system to physical load is correlating with an improvement in enzyme activity and stress indicators [5,6,7].

Although several studies have explored how the impact of plyometric training on muscle damage is affected by the nature of the landing and take-off surface, such as sand

against grass [16], sand against wood [24] and aquatic against land [26], and aquatic against sand and firm [15], No study has directly compared aquatic against grass in relation to muscle damage and inflammation when performing a similar number of plyometric jumps.

Therefore, the purpose of the present study was to compare protein catabolism indicator (blood urea nitrogen [BUN]), muscle damage indicators (lactate dehydrogenase (LDH) and myoglobin(Mb)) and inflammation indicator (interleukin (IL6)) after a single plyometric exercise (PE) session performed in water (AP) and on grass (GP) .

METHODS

Subjects

Fifteen healthy and physically active male third year students at the faculty of physical education for boys, with a mean age of 20.62 ±.59 years, a height of173.8 ± 4.95 cm, and a body mass of 72.67 ± 8.27 kg (Table 1) participated in this study .
No history of injury was reported in the previous six months.

TABLE 1. Subjects characteristics (N = 15).

	Mean	Standard deviation	Skewness
Age (y)	20.6200	0.59185	1.146
Body mass (kg)	173.8000	4.94542	0.841
Height (cm)	72.6667	8.26928	0.569

Biomedical Measurement

Indirect markers of protein catabolism [BUN] , muscle damage indicators (Mb) and (LDH) and inflammation indicator (IL6) were assessed before and after the plyometric exercise PE session.

- Measuring the pulse rate during plyometric exercise session to determine the severity of performance.

Blood sampling and analysis

Blood samples were taken from the cubital vein before and after training sessions, while the subjects were in a seated position.

To get the Mb concentration, a ELISA Test Kit (Myoglobin Enzyme Immunoassay Test Kit, Catalog Number: BC-1117) was used. The procedure followed the manufacturer guidelines. Urea was also measured using Urease-Berthelot Method (biodiagnostic,Dokki, Giza, Egypt) according to the manufacturer's instructions.
IL6 was measured using ELISA Kit (Biosourse, KAC1262,Belgium) according to the manufacturer's instructions.

Procedures

The Subjects performed PE session in a swimming pool with water at a depth of 130 cm (chest-deep) with a temperature of 28″C; and the same session on grass land.

This training session included unilateral and bilateral plyometric exercise , the session consists of 15 min warm up, doing one set of exercise to be familiar with PE training and then doing 300 jump as following in the table 2

Table (2) plyometric exercise session

Exercise	Sets	Repetition	Rest	Tempo
Sumo Squat Jump	5	12	On 2 m	Fast
Alternating Jump Lunge	5	12	On 2 m	Fast

Streamline Jump	5	12	On 2 m	Fast
Single Leg Squat Jump (right leg)	5	12	On 2 m	Fast
Single Leg Squat Jump (left leg)	5	12	On 2 m	Fast

Interval periods and number of repetitions were determined by reference [22].

Statistics

Statistical analysis was carried out using SPSS software version 21 (SPSS Inc., Chicago, IL, USA). It was checked that all the variables complied with the assumption of normality (Kolmogorov-Smirnov normality test) so we used parametric statistical.

Results

There are statistically significance differences between aquatic and grass group in pulse rate by using Independent Samples T test as shown in table (3)

Variables	Aquatic group		Grass group		T	Sig. (2-tailed)
	Mean	Standard deviation	Mean	Standard deviation		
Pulse rate	126.8800	13.72314	157.3067	10.17725	6.897	.000

Table (3) aquatic and grass group pulse rate by using Independent Samples T test (t) value on $p \leq 0.05 = 2.145$

There are significance increase between Pre- and Post in all biomedical markers (BUN,Mb,LDH,IL6) of the Aquatic group by using Paired Samples T test as shown in table 4

Table (4) Pre- and Post-biomedical markers of the Aquatic group by using Paired Samples T

	Pre		Post		Mean difference	Standard error	T	Sig
	Mean	Standard deviation	Mean	Standard deviation				
BUN	23.8667	5.87813	25.800	4.95984	1.93333	2.91466	2.569	.022
Mb	42.6667	10.26552	53.000	12.3866	10.33333	5.47288	7.313	.000
LDH	244.2667	47.69466	310.40	52.9188	66.13333	45.8115	5.591	.000
IL 6	1.8087	.50468	3.9947	.75560	2.18600	.70326	12.04	.000

test $p \leq 0.05 = 2.145$

There are significance increase between Pre- and Post in all biomedical markers (BUN,Mb,LDH,IL6) of the grass group by using Paired Samples T test as shown in table 5

	Pre		Post		Mean difference	Standard error	T	Sig
	Mean	Std. Deviation	Mean	Std. Deviation				
BUN	24.0667	4.63630	32.0667	4.25049	8.00000	3.22933	9.595	.000
Mb	41.8667	11.36955	92.2667	19.79707	50.40000	21.96686	8.886	.000
LDH	238.3333	56.52012	311.8667	67.15958	73.53333	41.55696	6.853	.000
IL 6	2.0827	.58099	5.8200	.80009	3.73733	.85758	16.88	.000

Table (5) Pre- and Post-Measurements of the grass group by using Paired Samples T test (t) value on p≤ 0.05 = 2.145

There are no statistically significance differences between aquatic and grass group Pre-training measurements of all biomedical markers (BUN,Mb,LDH,IL6) by using Independent Samples T test as shown in table 6

	Aquatic		Grass		T	Sig
	Mean	Standard deviation	Mean	Standard deviation		
BUN	23.8667	5.87813	24.0667	4.63630	0.103	.918
Mb	42.6667	10.26552	41.8667	11.36955	0.202	.841
LDH	244.2667	47.69466	238.3333	56.52012	0.311	.758
IL 6	1.8087	.50468	2.0827	.58099	1.379	.179

Table (6) aquatic and grass group Pre-training measurements of all biomedical markers by using Independent Samples T test (t) value on p≤ 0.05 = 2.145

there are statistically significant differences between aquatic and Grass group measurements in all variables of the research except LDH as shown in table 7.

	Aquatic		Grass		T	Sig
	Mean	Standard deviation	Mean	Standard deviation		
BUN	25.8000	4.95984	32.0667	4.25049	3.716	.001
Mb	53.0000	12.38663	92.2667	19.79707	6.512	.000
LDH	310.4000	52.91881	311.8667	67.15958	0.066	.948
IL 6	3.9947	.75560	5.8200	.80009	6.424	.000

Table (7) aquatic and Grass group measurements post training in all of all biomedical markers by using Independent Samples T test (t) value on p≤ 0.05 = 2.145

Discussion

The present study aimed to compare serum BUN, Mb, LDH and IL 6 response to aquatic and Grass plyometric session, the results showed that There are significance increase between Pre- and Post in all biomedical markers (BUN,Mb,LDH,IL6) of the aquatic and grass group as shown in table 4, 5 but the increasing in grass group is significantly higher in all biomedical markers except LDH than aquatic group as shown in table 7.

 We can explain the significantly increasing in grass group in BUN, Mb and IL6 as following:

    Regarding to the first variable (BUN), evidence suggests that there are factors affect in BUN levels include lean body mass, plasma volume, dietary protein, injury, and type and duration of exercise. Furthermore urea is one of several nitrogen compounds produced when an amino group of an amino acid is removed either for recycling into other proteins or being catabolized for energy or from tissue breakdown.

In this study the duration of exercise was long (over 1 hour) and intensity was higher in grass group than aquatic group as showed by Heart rate table, which cause protein catabolic, muscle damage and elevate of BUN.

    Regarding to the muscle damage indicators (Mb &LDH), it is known that strenuous plyometric training can damage the muscle cell membrane, which can result in the leakage of Mb and LDH, the present findings are in line with the results of previous studies [10, 18, 28].

Regarding to the fourth variable (muscle inflammation IL6)there are a Few of studies talked about the effect of plyometric exercise on inflammation, The results of these studies indicated an immediate significant increase in interleukin 6 (IL-6) immediately after stretch-shortening cycle exercise [9, 12] This is consistent with the findings of the results of the current study .

However the aquatic group results were more less than grass group in all biomedical markers perhaps because of lower oxidative stress produced by aquatic plyometrics, water buoyancy reduces forces the of impact with land, reduction of body weight in relation to the immersion level and decreasing the risk of injuries such as tendonitis, stress fractures, and other overuse injuries.

The present findings are in line with the results of previous studies, where the aquatic environment has demonstrated less change in muscle damage indicators due to slower and less intensive eccentric contraction and a more rapid neuromuscular recovery [25, 26, 28].

Conclusion

After comparing the experimental groups, it is clear that the aquatic plyometric group had lower statistical differences results than grass plyometric group for indicators of protein catabolism, muscle damage and muscle inflammation, therefore, the water environment provide an optimal environment for athletes to performing plyometric exercise.

Recommendations

The present study can recommend that coaches and strength & conditioning professionals use aquatic plyometric or safe surfaces like a firm surface for plyometric training to decrease muscle damage. Moreover, there is no financial support for this project and we did not measure some of the blood indicators of muscle damage, biopsy and MRI, which can be a subject for further research.

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