

Comparative and Interactive Effects of Land-and Aquatic-Based Plyometric Training on Agility and Peak Speed of Elite Young Athletes of the: Sporting Environment

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ABSTRACT: The purpose of the present study was to investigate the effects of a six-week *land-and aquatic-based plyometric training* on agility and peak speed of elite young athletes. 24 male elite young athletes (with average and standard deviation age of 19.16 ± 1.30 year., height 1.715 ± 8.826 m, weight 59.45 ± 8.93 kg) were tested at the beginning of the season. All subjects, after having been informed about the objective and protocol of the study, gave their written consents and the study was approved by Institutional Ethics Committee of Faculty of Sports Medicine and Physiotherapy and Directorate of Sports, Guru Nanak Dev University, Amritsar, India. The subjects were randomly assigned into three groups: *Land- based plyometric training group* (L; n = 08), *Aquatic-based plyometric training group* (A; n = 08), and control (C; n = 08). *Land-and aquatic-based plyometric training group* was subjected to 6-weeks plyometric training twice a week for 35 minutes a day. 505 agility test was used to monitor the development of the athlete's speed and agility whereas peak speed test was used to monitor the development of the athlete's ability to effectively and efficiently build up acceleration, from standing blocks, to maximum speed. It is concluded that the use of aquatic and land training program is not only to break the monotony of training, but they can also improve the strength of athletes, that ultimately leads to the optimal performance in the sports competition.

Keywords: aquatic; land; plyometric; agility; peak speed.

1. INTRODUCTION

Plyometrics has been a very popular training technique used by many coaches and training experts to improve speed, explosive power output, explosive reactivity and eccentric muscle control during dynamic movements [1]. Aquatic plyometric training (APT) is not a new concept, but it has recently become more popular, mostly because of the potential to decrease injuries, compared with land plyometric contractions, by decreasing impact forces on the joints. APT provides a form of training that can enhance performance during a competitive season for a power-based sport [2, 3]. It is suggested that APT has the potential to provide similar or better improvements in skeletal-muscle function and sport-related attributes of explosive and reactive training than land based plyometrics, with less delayed-onset muscle soreness [3-5]. Plyometric drills usually involve stopping, starting, and changing directions in an explosive manner. These movements are components that can

assist in developing agility [6-9]. Agility is the ability of a player to make changes in body direction and position rapidly and accurately without losing balance, in combination with fast movements of limbs [10-11] found what determined agility was the ability to combine muscle strength, starting strength, explosive strength, balance, acceleration, and deceleration. Agility requires rapid force development and high power output, as well as the ability to efficiently utilize the stretch shortening cycle in ballistic movements [12]. Plyometric training reduces the time required for voluntary muscle activation, which may facilitate faster changes in movement direction. Sprinting is a complex task that places a high neuromuscular demand on the performer and requires high levels of coordinated movement and appropriate sequencing of muscle activations to perform at peak levels. The fastest sprinters tend to have stride lengths and stride frequencies as great as 2.6m and 5 steps per second respectively [13]. Interestingly, the source of these outstanding characteristics is actually a single attribute. Previous research by Weyand and colleagues [14] indicates that force applied at ground contact is the most important determinant of running speed. Quickness, speed, and agility training are all inter-related and are designated as "neuromuscular" training. These drills will help the athlete react quicker and will enable the athlete to control the muscle with better co-ordination. Plyometrics improve speed, quickness, agility, and power but should not be used if recovering from an injury. The aim of the present study was to investigate the effects of a six-week land-and-aquatic-based plyometric training on agility and peak speed of elite young athletes

2 MATERIALS AND METHODS

2.1 Sample

A group of Twenty four (N=24) male elite young athletes, who participated in Punjab state athletic championship volunteered to participate in this study. Their mean age, height and weight were (Mean $\pm$ SD: age 19.16 ± 1.30 years, height 1.715 ± 0.0826 m, weight 59.45 ± 8.93 kg). All subjects, after having been informed about the objective and protocol of the study, gave their written consents and the study was approved by Institutional Ethics Committee of Faculty of Sports Medicine and Physiotherapy and Directorate of Sports, Guru Nanak Dev University, Amritsar, India. The subjects were randomly assigned into three groups: Land-based plyometric training group (L; n = 08), Aquatic-based plyometric training group (A; n = 08), and control (C; n = 08). Land-and-aquatic-based plyometric training group was subjected to 6-weeks plyometric training twice a week for 35 minutes a day.

Table 1. Subjects' Demographic

	Training Volume	Plyometric Drill	Sets x Repetitions	Training Intensity
1.	90	Side to side ankle hops. Standing long jumps. Front cone hops.	2 x 15 2 x 15 6 x 15	Low Low Low
2.	120	Side to side ankle hops. Standing long jump. Lateral jump over barrier. Double leg hops.	2 x 15 2 x 15 6 x 5 10 x 3	Low Low Medium Medium
3.	120	Side to side ankle hops. Standing long jump. Lateral jump over barrier. Double leg hops. Lateral cone hops.	2 x 12 2 x 12 6 x 4 8 x 3 2 x 12	Low Low Medium Medium Medium
4.	140	Single leg bounding. Standing long jump. Lateral jump over barrier. Lateral cone hops. Tuck jump with knees up	2 x 12 3 x 10 8 x 4 3 x 10 4 x 6	High Low Medium Medium Medium
5.	140	Single leg bounding. Jump to box. Double leg hops. Lateral cone hops. Tuck jump with knees up. Lateral jump over barrier	2 x 10 2 x 10 6 x 3 2 x 12 6 x 5 3 x 10	High Low Medium Medium High High
6.	120	Jump to box. Depth jump to prescribed height. Double leg hops. Lateral cone hops. Tuck jump with knees up. Single leg lateral jump.	2 x 10 4 x 5 6 x 3 2 x 10 4 x 5 2 x 10	Low Medium Medium Medium High High

2.2 Methodology

Measurement of Agility

- The objective of the 505 Agility Test (**DRAPER 1985**) is to monitor the development of the athlete's speed and agility. This test require the athlete to run total distance of 15m. The athlete is subjected to run from the -Start|| line to the -Turn|| line and return to the -Start|| line as fast as possible. The athlete must step past the -Turn|| line with both feet before returning.

6 cones are used with the distance between 10m in 1st&2nd cone and 5m in 2nd&3rd cones in line. Before commencing the test the athletes should warm up for 10 minutes. On giving the command -GO||, the athletes commences the test running from Line A to Line C and back as fast as possible. The assistant starts the stopwatch as the athlete passes the Line B on their way to the -Turn|| line. The assistant stops the stopwatch when the athlete passes line Bon their return to the|| Start|| line and record the time.

Measurement of Peak Speed

- The objective of this test is to monitor the development of the athlete's ability to effectively and efficiently build up acceleration, from standing blocks, to maximum speed. The assistant marks out 30 meters straight with cones. With 10 mins warm up the athlete require to starts in their own time and sprint as fast as possible over 30 meters. The assistant starts the stopwatch on the athlete's 1st foot strike after starting and stopping stopwatch as the athlete's torso crosses the finish line. The test is conducted 3 times and the fastest recorded time assesses the athlete's performance.

3. STATISTICAL ANALYSIS

Analysis of covariance (ANCOVA) was applied to study the significance of differences between the paired means and where F-ratio was found significant LSD post-hoc test was applied to find out the direction of difference. For testing the hypotheses, the level of significance was set at 0.05 level.

4. RESULTS

Table 2. Analysis of covariance of experimental groups and control group on the variable of peak Speed

Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.635	3	.545	4.451	.015
Intercept	495.133	1	495.133	4.045	.000
Variable	1.403	1	1.403	11.461	.003
Between groups	.232	2	.116	.946	.405
Within groups	2.448	20	.122		
Total	499.215	24			
Corrected Total	4.083	23			

Table 2 presents results of Analysis of covariance (ANCOVA) with regards to the variable of peak speed of three groups. The statistical values among the groups were: SS=.232, df=1 and MSS=.116. The within values were: SS=2.448, df=20 and MSS=.122. The F-value=.946 was found statistically not significant ($P>0.05$). Since obtained F-value was not found statistically significant among the groups therefore, Least significant difference (LSD) post-hoc test was applied to determine the direction and significance of difference among the groups.

Table 3. Significance difference of paired means of experimental groups and control group on the variable of Peak Speed

Group (A)	Group (B)	Mean Difference (A-B)	Sig
Aquatic Group (Mean=4.516)	Control	.088	.618
	Land	.166	.353
Control Group (Mean=4.428)	Aquatic	.088	.618
	Land	.255	.158
Land Group (Mean=4.682)	Aquatic	.166	.353
	Control	.255	.158

*Significant at .05 level

A glance at table 3 showed that the mean value of aquatic group was 4.516 whereas control group had mean value as 4.428 and the mean difference between both the groups was found .088. The p-value sig .618 shows that the aquatic group had demonstrated better on peak speed than their counterpart's control group though not significantly. The mean difference between aquatic and land group was found .166. The p-value sig .353 revealed that the land group had demonstrated better on peak speed than their counterpart's aquatic group though not significantly. The mean difference between land and control group was found .255. The p-value sig .158 showed that the land group had demonstrated better on peak speed than their counterpart's control group though not significantly.

Table 4. Analysis of covariance of experimental groups and control group on the variable of Agility

Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17.280	3	5.760	63.727	.000
Intercept	280.235	1	280.235	3.1003	.000
variable	17.113	1	17.113	189.325	.000
Between Groups	.168	2	.084	.927	.412
Within Groups	1.808	20	.090		
Total	299.323	24			
Corrected Total	19.088	23			

Table 4 presents results of Analysis of covariance (ANCOVA) with regards to the variable of agility of three groups. The statistical values among the groups were: $SS=.168$, $df=2$ and $MSS=.084$. The within values were: $SS=1.808$, $df=20$ and $MSS=.090$. The $F\text{-value}=.927$ was not significant ($P>0.05$). Since obtained $F\text{-value}$ was not found statistically significant among the groups therefore, Least significant difference (LSD) post-hoc test was applied to determine the direction and significance of difference among the groups.

Table 5. Significance difference of paired means of experimental groups and control group on the variable of Agility

Group (A)	Group (B)	Mean Difference (A-B)	Sig
Aquatic Group (Mean=3.324)	Control	.222	.182
	Land	.057	.707
Control Group (Mean=3.546)	Aquatic	.222	.182
	Land	.165	.303
Land Group (Mean=3.381)	Aquatic	.057	.707
	Control	.165	.303

*Significant at .05 level

A glance at table 5 showed that the mean value of aquatic group was 3.324 whereas control group had mean value as 3.546 and the mean difference between both the groups was found .222. The p-value sig .182 shows that the control group had demonstrated better on agility than their counterpart's aquatic group though not significantly. The mean difference between aquatic and land group was found .057. The p-value sig .707 revealed that the land group had demonstrated better on agility than their counterpart's aquatic group though not significantly. The mean difference between land and control group was found .165. The p-value sig .303 showed that the control group had demonstrated better on agility than their counterpart's land group though not significantly.

5. DISCUSSION

Success in many sports depends heavily upon the athlete's explosive leg power and muscular strength. In jumping, throwing, track and field events and other activities, the athlete must be able to use strength as quickly and forcefully as possible. To any sport that requires powerful, propulsive movements, such as, sprinting, high jump, long jump, the application of Plyometric training is applicable. The focus of this preliminary study was to examine effects of a six-week land-and aquatic- based Plyometric training on agility and peak speed of elite young athletes. A perusal at Analysis of Variance (ANOVA) tables 2 with regard to peak speed of experimental groups and control group revealed insignificant differences among three groups. These findings substantiate the assertion [15] wherein they found that why APT can improve speed is due to the physical properties of water. Viscosity and cohesion of water increases this resistance, providing an important training

stimulus for agility within an aquatic environment [16]. Also, the collective effect of speed specificity, repetitive jump training with the shorter amortization phase, could too result in improved agility [17]. Aquatic Plyometric could also offer an effective training modality for performance enhancement in power-based and speed of athletes in sports such as rugby union football. Aquatic-based Plyometric should not completely replace land-based Plyometric, as it might not adequately develop the specific neuromuscular patterns or functional needs of explosive sports. It has also been observed from the above Analysis of Variance (ANOVA) tables 4 with regard to agility of experimental groups and control group revealed insignificant differences among three groups. These findings contrary the assertion of [18] they believed that to enhance explosive muscle power and dynamic athletic performance, complex agility training can be used. Therefore, in addition to the well-known training methods such as Plyometric training, strength and conditioning professionals may efficiently incorporate agility training into an overall conditioning programme of athletes striving to achieve a high level of explosive leg power and dynamic athletic performance. Similar trends have been reported by Aquatic-based Plyometric training could provide similar and even better performance in agility than land-based plyometric training, in an adolescent male population. Land-based Plyometric training could provide greater improvement in peak speed in this population. They also assumed that for any exercise prescription, focus should be to improve the functional or sport specific movements with exercises that approximate the demands of the desired activity speed, agility, strength power, endurance [19]. Specificity of exercise prescription means that exercise and training prescription must be designed to meet the demands of the participant's sport.

6. CONCLUSION

The results from our study can be beneficial to the young athletes with the benefits of improving agility with the lesser risk of injuries in water environment. It is concluded that the use of aquatic and land training program is not only to break the monotony of training, but they can also improve the strength of athletes, that ultimately leads to the optimal performance in the sports competition.

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