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Effect of land plyometric and sand plyometric training on selected physical and physiological variables among hockey players

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Abstract
Modern Hockey demands that all the players should be adapted to all the situations either defending or attacking. The game of hockey now a day is being played in three types of grounds namely gravel, grass and artificial ground. After the introduction of the artificial field the players, coaches and the conditioning experts now understand that the physical variables are playing vital role to reach high level performance in the artificial ground. The purpose of the study was find out the Effect of land Plyometric and Sand Plyometric Training on Selected Physical and Physiological Variables among Hockey Players. Sixty men Hockey players studying from Alagappa University College of Physical Education, Karaikudi, Tamil Nadu, were selected randomly as subjects. Their age ranged from 18 to 24. Twenty subjects were distributed into three equally groups. Group – I control group, Group – II land plyometric training, group– III sand plyometric training. The experimental groups with varied load and velocity underwent their respective training programme for three day in a week for eight weeks. The data were analyzed statistically through anacova to find out the significant difference, the scheffe's was applied as post hoc test to find out the paired mean difference. There was a significant improvement on control group, land plyometric training group and sand plyometric training group on selected physical variables namely Speed, Agility and physiological variable of Cardio respiratory endurance. The significance difference between land plyometric and sand plyometric training on agility. There was no significance difference on speed and Cardio respiratory endurance of between experimental groups.

Keywords: Plyometric, sand, speed, agility and Cardio respiratory endurance.

Introduction
Plyometric training consists of quick, explosive movements designed to increase speed and power. This can be achieved through performing multiple exercises that focus on training our bodies and brains to activate more muscle fibers, more quickly, in order to increase the efficiency and speed of our muscle contractions. Plyometric drills usually involve stopping, starting, and changing directions in an explosive manner. These movements are components that can assist in developing agility (Craig, 2004; Miller *et al*., 2001) [9, 17]. Agility is the ability to maintain or control body position while quickly changing direction during a series of movements. Agility training is thought to be a reinforcement of motor programming through neuromuscular conditioning and neural adaptation of muscle spindles, golgi tendon organs, and joint proprioceptors (Craig, 2004, Potteiger *et al*., 1999) [9, 22]. By enhancing balance and control of body positions during movement, agility theoretically should improve. Sand training is, first and foremost training with a great option for developing strength and power, building lower body muscle and creating specific adaptations for competition (Palfrey M.2012) [21]. Plyometric training on a sand surface can play a role in shock absorption and reduce stress on bones and tissues (Bishop, 2003) [5]. However, the friction and instability of sand can induce negative effects on stretch shortening cycle, decreases in the myotatic reflex, degradation of elastic energy potentiating and an increase in the amortization phase resulting in performance decrements (Giatsis, Kollias, Panoutsakopoulos, & Papaiakovou, 2004; Impellizzeri, *et al*., 2008) [11, 13].

The game of field hockey is a high intensity, non-continuous game in which the physiological demands are considerable, placing it in the category of 'heavy exercise' (Ghosh *et al*., 1991; Reillt & Borrie, 1992) [10, 25].

The unique requirements of field hockey including dribbling the ball and moving quickly in a semi-crouched posture superimpose the workload demanded by the game (Reilly & Seaton, 1990) [26]. Competitive field hockey matches place heavy aerobic demands on players and require them to expend energy at relatively high levels (Reilly & Borrie, 1992) [25] (Boyle *et al*., 1994) [6]. While intermittent in nature, players are required to perform continuously for 70 minutes with just one 5-10 minute interval (Boyle *et al*., 1994) [6]. Although the majority of the game is spent in low-level activity such as walking and light jogging, repeated back-to-back sprints make speed and tolerance to lactic acid an important characteristic in players (Spencer *et al*., 2004) [30]. The game of hockey now a day is being played in three types of grounds namely gravel, grass and artificial ground. After the introduction of the artificial field the players, coaches and the conditioning experts now understand that the physical variables are playing vital role to reach high level performance in the artificial ground. Johnson and Nelson said that the agility may be explained as the physical ability which enables an individual to rapidly change body position and direction. The absence of that ability among the participants would spoil the original game score.

Aim of This Study

The aim of this study was to compare the Effect of land Plyometric and Sand Plyometric Training on Selected Physical and Physiological Variables among Hockey Players.

Objectives of the Study

To find out the effectiveness of land plyometric training and sand plyometric training on selected physical variables (speed and agility) and physiological variable (Cardio respiratory endurance) of the college hockey men players.

Hypotheses

1. It is hypothesized that there was significant improvement in selected physical and physiological variables after eight weeks of land Plyometric Training and sand Plyometric Training.
2. It is hypothesized that there was significant difference in selected physical and physiological variables after eight weeks of land Plyometric Training and sand Plyometric Trainings.

Method and Procedure

For the present study, sixty men Hockey players studying Alagappa University College of Physical Education, Karaikudi, Tamil Nadu, were selected randomly as subjects. Their age ranged from 18 to 24. Twenty subjects were distributed into three equally groups. Group – I control group, Group – II land plyometric training, group– III sand plyometric training. The experimental groups with varied load and velocity (intensity) underwent their respective training programme for three day in a week for eight weeks.

Dependent Variables

Physical variables

a. Speed
b. Agility

Physiological variable

a. Cardio respiratory endurance

Independent Variables

Group I - control group
Group II - land plyometric training
Group III - sand plyometric training.

Criterion Measures and Tools Used

Criterion measure	Test items	Unit of measurement
Speed	50 Mts run	In seconds
Agility	T test	In seconds
Cardio respiratory endurance	12 mint run/walk	In Meters

Plyometric Training Programme

The study adopted a eight weeks 45 min in a day and for alternate days/weeks. The training program began with low volume plyometric drills and progressively increased in volume and intensity until the completion of the study.

Training Weeks	Training volume	Plyometric Drills	Sets x Repetitions
1&2	80-100	Single leg jump	2×10
		Double leg hops	2×10
		Power skipping (high knees)	2×10
		Side-to-side-ankle hops	2×10
		Standing jump and reach	2×10
3&4	100-120	Single leg jump	2×12
		Double leg hops	2×12
		Power skipping (high knees)	2×12
		Side-to-side-ankle hops	2×12
		Standing jump and reach	2×12
5&6	100-120	Single leg jump	3×12
		Double leg hops	3×12
		Power skipping (high knees)	3×15
		Side-to-side-ankle hops	3×12
		Standing jump and reach	3×15
7&8	120-140	Single leg jump	3×15
		Double leg hops	3×15
		Power skipping (high knees)	3×20
		Side-to-side-ankle hops	3×15
		Standing jump and reach	3×20

Statistical Design

Statistical analysis was done by using Microsoft windows (version SPSS 20). The data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significant difference, if any among the groups whenever they obtained 'F' ratio was found to be significant, the scheffe's was applied as post hoc test to find out the paired mean difference. The level of significance was set at 0.05 level.

Results

The analysis of covariance on speed of the pre and post test scored of control group; land plyometric training group and sand plyometric Training Group have been analyzed and presented in Table I.

Table I: Analysis of Covariance on Speed of Control Group, Land Plyometric Training Group and Sand Plyometric Training Groups

	Sand plyometric training	Land plyometric group	Control group	Source of Variance	Sum of Squares	Df	Mean Squares	'F' Ratio
Pre test	8.00	8.17	8.01	B	0.37	2	0.185	0.45
				W	23.06	57	0.404	
Post test	7.60	7.57	8.28	B	6.00	2	3.00	7.50*
				W	23.00	57	0.400	
Adjusted Post test	7.52	7.62	8.30	B	7.25	2	3.625	11.96*
				W	16.98	56	0.303	

* Significant at .05 level of confidence. (The table values required for significance at 0.05 level of confidence for 2 and 57 and 2 and 56 are 3.16)

The table I show that the adjusted post-test means of control group; land plyometric training group and sand plyometric training groups are 8.30, 7.62 and 7.52 respectively on speed. The obtained "F" ratio of 11.96 for greater than the table value of 3.16 for df 2 and 56 required for significance at 0.05 level of confidence on speed. The results of the study indicated that there was a significant difference among the adjusted post-test means of control group; land plyometric training group and sand plyometric training groups on speed.

Table II: Analysis of Covariance on Agility of Control Group, Land Plyometric Training Group and Sand Plyometric Training Groups

	Sand plyometric training	Land plyometric group	Control group	Source of Variance	Sum of Squares	Df	Mean Squares	'F' Ratio
Pre test	12.64	12.95	13.00	B	1.521	2	0.761	1.44
				W	30.050	57	0.527	
Post test	11.69	12.50	12.75	B	12.424	2	6.212	14.33*
				W	24.704	57	0.433	
Adjusted Post test	11.84	12.43	13.15	B	6.786	2	3.393	19.08*
				W	9.957	56	0.178	

* Significant at .05 level. (The table values required for significance at .05 level of confidence for df 2 and 57, df 2 and 56 are 3.16).

The table II show that the adjusted post-test means of control group, land plyometric training group and sand plyometric training groups are 13.15, 12.43 and 11.84 respectively on Agility. The obtained "F" ratio of 19.08 for greater than the table value of 3.16 for df 2 and 56 required for significance at 0.05 level of confidence on Agility. The results of the study indicated that there was a significant difference among the adjusted post-test means of control group; land plyometric training group and sand plyometric training groups on Agility.

Table III: Analysis of Covariance on Cardiorespiratory Endurance of Control Group; Land Plyometric Training Group and Sand Plyometric Training Groups

	Sand plyometric training	Land plyometric group	Control group	Source of Variance	Sum of Squares	Df	Mean Squares	'F' Ratio
Pre test	1882.50	1819.75	1789.00	B	90835.33	2	45417.91	2.91
				W	889778.75	57	15610.15	
Post test	1999.25	1926.00	1788.00	B	460240.83	2	230120.41	13.29*
				W	986713.75	57	17310.76	
Adjusted Post test	1948.23	1936.44	1828.56	B	163449.15	2	81724.57	34.39*
				W	133063.12	56	2376.12	

* Significant at .05 level. (The table values required for significance at .05 level of confidence for df 2 and 57, df 2 and 56 are 3.16).

The table III shows that the adjusted post-test means of control group, land plyometric training group and sand plyometric training groups are 1828.56, 1936.44 and 1948.23 respectively on cardio respiratory endurance. The obtained "F" ratio of 34.39 for greater than the table value of 3.16 for df 2 and 56 required for significance at 0.05 level of confidence on cardio respiratory endurance. The results of the study indicated that there was a significant difference among the adjusted post-test means of control group; land plyometric training group and sand plyometric training groups on cardio respiratory endurance.

Table IV: Scheffee's Post - hoc Test for Mean Differences between Groups of Speed, agility and cardio respiratory endurance.

	Sand plyometric training	Land plyometric group	Control group	Mean Differences	C.I
Speed	7.52	7.62	-	0.10	0.43
	7.52	-	8.30	0.67*	
	-	7.62	8.30	0.78*	
Agility	11.84	12.43	-	0.59*	0.33
	11.84	-	12.65	0.81*	
	-	12.43	12.65	0.71*	
Cardio Respiratory Endurance	1948.23	1936.44	-	11.78	38.67
	1948.23	-	1828.56	119.66*	
	-	1936.44	1828.56	107.88*	

* Significant

Table IV shows that the mean difference values of control and sand Plyometric training, control and land Plyometric training groups on speed were 0.67, and 0.78 respectively which were greater than the confidence interval value of 0.43. Sand Plyometric training and land Plyometric training group mean difference 0.10.which was less than confidence interval value. Hence it was not significant. The mean difference values of land Plyometric training group and sand plyometric training groups, sand plyometric training and control, land plyometric training and control groups on Agility were 0.59, 0.81 and 0.71, respectively. The comparison of control, land plyometric and sand plyometric training group was greater than the confidence interval value of 0.33. The mean difference values of control and sand plyometric training group, control and land plyometric training groups on cardio respiratory endurance were 119.66, and 1107.88 respectively, which were greater than the confidence interval value of 38.67. Sand plyometric training group and land plyometric group mean difference at 11.78 which was less than confidence interval value. Hence it was not significant difference.

Discussion

The aim of this study was to the effect of land plyometric and sand plyometric training on selected physical and physiological variables among hockey players. In this study an eight weeks of land plyometric and sand plyometric training programmed was done and the entire three functional tests were performed for both the group. To the best of our knowledge, one study has been conducted to compare the effects of land and sand plyometric training program on speed. In this study the speed performance is sand plyometric training better than land plyometric training group Arumugam.c *et al* (2011) [2]. Impellizzeri *et al* (2008) [13] reported significant benefits of sand plyometric training on sprint performance. The many studies proved that land plyometrics had positive effect to improve the speed Ozbar. N, *et al* (2014) [20], Sethu. S (2014) [28], Markovic *et al*. (2007) [16] and Thomas *et al*, (2009) [31] the rates of improvements in sprint were greater. The previous studies that reported positive effects of land plyometric training on agility performance Rameshkannan S and Chittibabu.b (2014) [24], Sethu. S (2014) [28], Raj kumar (2013) [23], Arazi H and Asadi A (2012) [1]. Agility improvement requires rapid force development and high power output. Senthil, P. (2015) [27] conducted research to 12-weeks of plyometric exercise programme significantly improved the cardio respiratory endurance. The present study showed that there is improvement in all the three performance within the group but there is no difference in speed and cardio respiratory endurance between the experimental groups. The agility was significant difference between experimental groups. Training on the sand plyometric can be very beneficial because it has less impact than the ground. The findings of this study indicate that plyometric training on sand and land can be used effectively as a training surface for improving speed, agility and cardio respiratory endurance.

Conclusions

The present study indicates that 8 weeks program of land plyometric training group and sand plyometric training group can produce significant increases in selected physical variables namely Speed, Agility and physiological variable of Cardio respiratory endurance. The significance difference between land plyometric and sand plyometric training on agility. There was no significance difference on speed and cardiovascular endurance of between experimental groups. Consequently both surfaces can be used for improving speed, agility and cardio respiratory endurance in hockey players.

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