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Effect Of Plyometric Training On Different Surfaces On Explosive Power And Muscular Endurance Performance Of Male Volleyball Players

T. Shibindev[1] , Dr. P. Kulothungan[2]

[1]Ph.d -Scholar, Department of Physical Education, Annamalai University, Tamilnadu, India

[2]Associate Professor, Department of Physical Education, Annamalai University, Tamilnadu, India
Corresponding mail: - shibindevt97@gmail.com - pkuloth@gmail.com

Abstract

The purpose of the study was to find out the effect of plyometric training on different surfaces on explosive power and muscular endurance performance of male volleyball players. To achieve this purpose forty five male volleyball players studying in the various courses, Annamalai university campus, Chidambaram, Tamil Nadu, India, were randomly selected and divided into three groups of fifteen each. The age of the subjects, ranged from 18 to 24 years. This study consisted of two experimental variables the plyometric training on sand surface (PTSSG) and the plyometric training on wooden surface (PTWSG). The allotment of groups was done at random, thus the Group-I underwent plyometric training on sand surface, the Group-II underwent plyometric training on wooden surface for three days per week for twelve weeks and the Group-III acted as control was not given any specific training. All the subjects were tested prior to and after the experimentation period. The collected data were statistically treated by using ANCOVA, and 0.05 level of confidence was fixed to test the significance. When the obtained 'F' ratio was significant, Scheffe's post hoc test was used to find out the significant difference among the paired mean differences. The study revealed that the of plyometric training on sand surface and plyometric training on wooden surface

groups have significantly improved in explosive power and muscular endurance as compared to the control group. The result also reveals that the improved in explosive power and muscular endurance is significantly more for plyometric training on sand surface group as compared with plyometric training on wooden surface group.

KEY WORDS: Plyometric Training, Sand, Wooden, Surfaces, Explosive Power, Muscular Endurance.

Introduction

Sports training are a process of long duration and progressive in nature and not achieved over a day. It also develops an all-round development of a player and enables him to contribute a lot to the society. Sports performance mainly depends on motor skills and techniques that are directly related to a particular sport or a game. It improves optimum level of an individual or team efficiency through regular and scientific process. Sports training is a set of exercises constructed to enhance the efficiency of a player through progressive and repetitive process.

Plyometric training one of the popular sports trainings for the reason that it has significant positive effect on the performance of a player or an athlete who involve in it. This training is mainly planned to improve the relationship amid maximum strength and explosive power with an improved performance. This training mainly enhances the muscular strength and jumping performance of the sportsmen involved in it and hence it leads to the improvement of explosive power.

The rate of force development is at the maximum for any type of muscle action is explosive power. Explosive power can be increased, either by increasing the amount of work or by decreasing the amount of time. In throwing and jumping events, serving in tennis are some of the sticking examples for power [Ioannis et al., 2000]. Vertical explosive power is frequent actions in volleyball practices and games, playing a very important role in both attack and counterattack. Vertical explosive power is an important predictor of performance in several sports that require explosive action [Sridar & Arumugam., 2019]. Vertical jump performance is one of the best indications of lower limbs muscle power. There is an eccentric movement of agonist muscles followed by a concentric movement, and jump performance

results, mostly, from the use of the elastic energy produced in the stretch shortening cycle [Kraska et al., 2009]. The horizontal jumps are challenging events for which to develop strength and conditioning programs. Both require strength, speed, power and technique. This is achieved by focusing on exercises such as squats, lunges and pulls requiring the athlete to exert force against the ground [Mendoza & Nixdorf., 2011].

Plyometric training on different surfaces may be associated with different training-induced effects on some neuromuscular factors related to the efficiency of the stretch-shortening cycle [Impellizzeri et al., 2008]. Vertical jump on sand surface is lower than hard surface because of sand surface is more instability and this instability decreases maximum power and take off velocity. Furthermore jump kinematics is different on sand surface than hard surface [Giatsis et al., 2004]. Arazi et al., (2014) recommended that training on hard surface for sprint, jump performance and training on sand surface for agility and strength performance according to results their study performed 6 week plyometric training on different surface of healthy male subjects. Cimenli et al., (2016) demonstrated similar jump height improvements in male volleyball players after PJT conducted on wooden and synthetic surfaces. Very recently, Ramirez-Campillo et al., (2020) examined the effects of 8 weeks of combined-surface PJT (grass, land-dirt, sand, wood, gym mat, and tartan-track) vs. single-surface PJT (grass) on physical fitness components in male adolescent soccer players. Although both training modalities reported significant improvements in countermovement jump (CMJ), drop jump from 20 cm (DJ20), CODS and 30 m sprint time, the advancements were in favour of combined surfaces during PJT. Another study on young male volleyball players observed a greater vertical jump height improvement following a 2-week PJT in sand compared to a rigid surface [Suresh et al., 2017]. A previous study, conducted by Sanchez-Sanchez et al., (2020) team sport athletes, the optimal type of surface for PJT has not been identified. To date, a few well controlled studies have examined the potential effects of different PJT surfaces on components of physical fitness and explosive performance in athletes.

Although the majority of studies in volleyball players performance were evaluated on hard surfaces and there are very limited studies the effects of different surfaces such as sand or wooden on volleyball performance. Therefore the aim of this study

was to investigate the effect of plyometric training performed on two different surfaces that sand and wooden surfaces on jumping performance of adult male volleyball players. Although many studies have investigated the athletic performances on different surfaces, there is no knowledge of the effect of long term plyometric training on different indoor surfaces of jumping performance for volleyball players. In this manner it would be important to investigate whether differences between wooden or land surface to plyometric training for jumping heights. Many studies in literature jump heights lower on sand surfaces than hard material surfaces. Therefore, the main aim of this study was to investigate the effect of plyometric training on different surfaces on explosive power and muscular endurance performance of male volleyball players.

Methods and Procedures

The purpose of the study was to find out the effect of plyometric training on different surfaces on explosive power and muscular endurance performance of male volleyball players. To achieve this purpose forty five male volleyball players studying in the various courses, Annamalai university campus, Chidambaram, Tamil Nadu, India, were randomly selected and divided into three groups of fifteen each. The age of the subjects, ranged from 18 to 24 years. This study consisted of two experimental variables the plyometric training on sand surface (PTSSG) and the plyometric training on wooden surface (PTWSG). The allotment of groups was done at random, thus the Group-I underwent plyometric training on sand surface, the Group-II underwent plyometric training on wooden surface for three days per week for twelve weeks and the Group-III acted as control was not given any specific training.

Exercise Training Programme

During the training period the following two experimental groups were formed. The experimental group 1- for plyometric training on sand surface and experimental group 2- for plyometric training on wooden surface. Two training groups underwent their respective training programmes on three alternative days each week, for twelve weeks. All the experimental groups underwent their respective training programme as per schedule under the supervision of qualified volleyball coaches along with the researcher who provided motivation, advice and encouragement

to the players. During training day, plyometric training schedule was performed in the morning session that lasted ninety minutes (6.30 am to 8.00am). Prior to and after every training session players of all experimental groups had fifteen minutes of warm-up and fifteen minutes of cooling down exercises involving jogging, mobility and stretching exercises.

Statistical Technique

The data collected from the three groups prior to and post experimentation were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since three groups were involved, whenever the obtained F ratio was found to be significant for adjusted post test means, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any. In all the cases statistical significance was fixed at .05 levels.

TABLE- 1 TRAINING SCHEDULE FOR SAND SURFACE PLYOMETRIC TRAINING (Twelve Weeks)

Week	Name of the Drills	Intensity	Repetition	Set
I -IV Week	• 15 Mts Double Leg Bound • 15 Mts Alternate Leg Bound • 15 Mts Double Leg Box Bound • 15 Mts Double Leg Pace Hop • 15 Mts Single Leg Pace Hop • 15 Mts Side Hop • 15 Mts Squat Jump • 15 Mts Knee-Tuck Jump • 15 Mts Split Jump	60%	**2** **2** **2** **2** **2** **2** **2** **2** **2** **2**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**

	• 15 Mts Side Jump			
V -VIII Week	• 20 Mts Double Leg Bound • 20 Mts Alternate Leg Bound • 20 Mts Double Leg Box Bound • 20 Mts Double Leg Pace Hop • 20 Mts Single Leg Pace Hop • 20 Mts Side Hop • 20 Mts Squat Jump • 20 Mts Knee-Tuck Jump • 20 Mts Split Jump • 20 Mts Side Jump	65%	**3** **3** **3** **3** **3** **3** **3** **3** **3** **3**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**
IX -XII Week	• 25 Mts Double Leg Bound • 25 Mts Alternate Leg Bound • 25 Mts Double Leg Box Bound • 25 Mts Double Leg Pace Hop • 25 Mts Single Leg Pace Hop	70%	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**

	• 25 Mts Side Hop • 25 Mts Squat Jump • 25 Mts Knee-Tuck Jump • 25 Mts Split Jump • 25 Mts Side Jump			

Recovery in-between Exercise: 60 sec
Recovery in between Sets : 3 Minutes

TABLE- 2 TRAINING SCHEDULE FOR WOODEN SURFACE PLYOMETRIC TRAINING (Twelve Weeks)

Week	Name of the Drills	Intensity	Repetition	Set
I -IV Week	• 15 Mts Double Leg Bound • 15 Mts Alternate Leg Bound • 15 Mts Double Leg Box Bound • 15 Mts Double Leg Pace Hop • 15 Mts Single Leg Pace Hop • 15 Mts Side Hop • 15 Mts Squat Jump • 15 Mts Knee-Tuck Jump • 15 Mts Split Jump • 15 Mts Side Jump	60%	**2** **2** **2** **2** **2** **2** **2** **2** **2** **2**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**

V -VIII Week	• 20 Mts Double Leg Bound • 20 Mts Alternate Leg Bound • 20 Mts Double Leg Box Bound • 20 Mts Double Leg Pace Hop • 20 Mts Single Leg Pace Hop • 20 Mts Side Hop • 20 Mts Squat Jump • 20 Mts Knee-Tuck Jump • 20 Mts Split Jump • 20 Mts Side Jump	65%	**3** **3** **3** **3** **3** **3** **3** **3** **3** **3**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**
IX -XII Week	• 25 Mts Double Leg Bound • 25 Mts Alternate Leg Bound • 25 Mts Double Leg Box Bound • 25 Mts Double Leg Pace Hop • 25 Mts Single Leg Pace Hop • 25 Mts Side Hop • 25 Mts Squat Jump • 25 Mts Knee-Tuck Jump • 25 Mts Split Jump	70%	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**

	• 25 Mts Side Jump			

Recovery in-between Exercise : 60 sec
Recovery in between sets : 3 Minutes

Results of Study

TABLE – 3 ANACOVA FOR BEFORE TRAINING AND AFTER TRAINING ON EXPLOSIVE POWER AND MUSCULAR ENDURANCE OF EXPERIMENTAL AND CONTROL GROUPS

VARIABLES		PTSSG	PTWSG	CG	SOV	SS	df	MS	F- ratio
Explosive Power	Pre test Mean SD	52.40	52.93	52.80	B	2.31	2	1.15	0.32
		2.13	1.66	1.82	W	148.93	42	3.54	
	Post test Mean SD	60.46	57.86	53.20	B	406.71	2	203.35	30.73*
		2.16	3.22	2.17	W	277.86	42	6.61	
	Adjusted Post Test Mean	60.52	57.82	53.18	B	411.77	2	205.88	31.03*
					W	271.95	41	6.63	
Muscular Endurance	Pre test Mean SD	35.46	35.60	36.20	B	4.57	2	2.28	1.14
		1.59	1.35	1.26	W	83.73	42	1.99	
	Post test Mean SD	44.60	40.93	36.33	B	514.71	2	257.35	32.76*
		2.99	3.51	1.49	W	329.86	42	7.85	
	Adjusted Post Test Mean	44.65	40.96	36.25	B	505.47	2	252.74	31.65*
					W	327.39	41	7.98	

The adjusted post test mean values on explosive power of PTSSG, PTWSG and CG were 60.52, 57.82 and 53.18 respectively. The

obtained 'F' ratio of 31.03 for adjusted post test scores was greater than the table value of 3.22 for df 2 and 41 required for significance at 0.05 level of confidence on explosive power. The results of the study indicated that there was significant difference between the adjusted post test means of PTSSG, PTWSG and CG on explosive power.

The adjusted post test mean values on muscular endurance of PTSSG, PTWSG and CG were 44.65, 40.96 and 36.25 respectively. The obtained 'F' ratio of 31.65 for adjusted post test scores was greater than the table value of 3.22 for df 2 and 41 required for significance at 0.05 level of confidence on muscular endurance. The results of the study indicated that there was significant difference between the adjusted post test means of PTSSG, PTWSG and CG on muscular endurance.

TABLE – 4 SCHEFFE'S POST HOC TEST FOR THE ADJUSTED POST-TEST PAIRED MEANS DIFFERENCE ON EXPLOSIVE POWER AND MUSCULAR ENDURANCE

	Adjusted Post-Test Means			Mean difference	Confidence Interval
	PTSSG	**PTWSG**	**CG**		
EXPLOSIVE POWER	60.52	57.82		2.70*	2.31
	60.52		53.18	7.34*	2.31
		57.82	53.18	4.64*	2.31
MUSCULAR ENDURANCE	44.65	40.90		3.69*	2.53
	44.65		36.25	8.40*	2.53
		40.90	36.25	4.71*	2.53

***Significant at 0.05 level of Confidence.**

The table -4 shows that the adjusted post test paired mean difference between plyometric training on sand surface group and plyometric training on wooden surface group, plyometric training on sand surface group and control group and plyometric training on wooden surface group and control group are 2.70, 7.34 and 4.64 for explosive power and 3.69, 8.40 and 4.71 for muscular endurance respectively. They were greater than the confidence interval value of 2.31 and 2.53 at 0.05 levels which indicate that the twelve weeks of plyometric training on sand surface and plyometric training on wooden surface groups have significantly

increased explosive power and muscular endurance as compared to the control group. The result also reveals that the increase in explosive power and muscular endurance is significantly improved for plyometric training on sand surface group as compared with plyometric training on wooden surface group.

Discussion on Finding

The result of present study was that explosive power and muscular endurance have increased significantly PTSSG and the PTWSG as compared to the CG. However the result of the present study also reveals that the increase in explosive power and muscular endurance were significantly more for the PTSSG than the PTWSG volleyball players. Substantial and beneficial gains in explosive power and muscular endurance parameters have been reported in most of the studies conducted previously. The results of the present study are also in line with the results observed from the previous studies. Amrinder et al., (2014) have proved that short-term plyometric training on sand/non-rigid surface induces similar improvements in strength endurance, balance and agility as on firm surface but induces significantly less muscle soreness. Bishop (2003) have concluded that land-based tests can be used to assess sand jumping ability in experienced beach volleyball players. Ramlan et al., (2018) have found that four weeks of plyometric training led to a significant improvement in post test of squat jump and countermovement jump for both grass surface and concrete surface volleyball players. Impellizzeri et al., (2008) sand group experienced less muscle soreness than those in the grass group ($p<0.001$). Plyometric training on sand improved both jumping and sprinting ability and induced less muscle soreness. A grass surface seems to be superior in enhancing countermovement jump performance while the sand surface showed a greater improvement in squat jump. Cimenli et al., (2016) have concluded plyometric training wooden and synthetic surface significant differences for improve vertical jump and horizontal jumping performance in healthy adult male volleyball players. Ojeda-Aravena et al., (2022) have proved that performance related to the counter movement jump with arms on softer surfaces after 4-week plyometric training improved vertical jump displacement and lower body power in rugby seven players. Ozkanet al., (2016) have concluded plyometric training on wooden or synthetic surfaces haven't significant differences for improving jumping performance in healthy adult male volleyball players.

Shrikant and Mankar., (2020) have showed that all training treatments elicited significant ($p < 0.05$) improvement in all tested variables. However, the sand plyometric training group produced improvements in vertical jump performance and leg strength that were significantly greater performance in compare with the land and control group. Stemm and Jacobson (2007) have suggested that the aquatic- and land-based groups significantly ($p < 0.05$) outperformed the control group in the vertical jump. Ragavan Ambili and Maniazhagu (2019) study clearly indicate that performance of explosive power was improved due to the 12 weeks of low volume plyometric training on sand surface with SAQ drills and moderate volume plyometric training on sand surface with SAQ drills. Fabricius, (2011) have concluded significantly improved on vertical jump, standing broad jump, agility and speed for both aquatic plyometric training and land plyometric training as compared to the control group in rugby union football. Manoranjith et al., (2020) have concluded that both plyometric training with aerobic training on indoor surface group and plyometric training with aerobic training on outdoor surface group had significant improvement on agility and explosive power when compared to control group. Buga and Gencer. (2022) have concluded that plyometric exercise applied in agua surface, grass surface and parquet surface positively improve the vertical jump, agility, balance and anaerobic power performance of 12-15 age group basketball players.

Conclusions

The analysis of data revealed significant improvement on explosive power and muscular endurance have increased significantly for the PTSSG and the PTWSG as compared to the CG. However the result of the present study also reveals that the increase in explosive power and muscular endurance were significantly more for the PTWSG than the PTSSG volleyball players.

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