Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 6 (2023)

Impact of Plyometric Training on Different Surfaces on Speed and Agility Performance of Male Volleyball Players

T. Shibindev, Dr. P. Kulothungan,

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

Associate Professor, Department of Physical Education, Annamalai University, Tamilnadu, India

Abstract

The purpose of the study was to find out the impact of plyometric training on different surfaces on speed and agility 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 speed and agility as compared to the control group. The result also reveals that the improved in speed and agility are 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, Speed, Agility.*

Introduction

Volleyball is a popular sport which has thousands of supporters and practitioners at the international area and a competitive sport played on different surfaces such as indoors or outdoors courts. Indoor volleyball is played upon a hard flat surface that is mostly made out of wood or synthetic materials [Gortsila et al., 2013]. Jumping ability is very important ability for success in volleyball and it very connected with surface. Guruvupandian and Murugavel (2017) investigated the influence of high intensity plyometric training program on motor fitness variables of intercollegiate male handball players. The study revealed that the Speed (50meters dash), agility (shuttle run) parameters were significantly improved due to influence High Intensity Plyometric training. Aashish et al., (2015) investigated the effect of plyometric training program on the agility performance among male basketball players. The results found that there was significant effect of 6 week plyometric training program on agility (Barrow's Zig Zag test) in young male basketball players. Nurper (2015) examined how to speed, explosive strength, and kicking speed are affected by a 10-week plyometric training (PT) program in elite female soccer players. The result shows that significant changes in the speed due to 6 week plyometric training program in elite soccer players. Michailidis (2015) investigated the effectiveness of plyometric training on performance of preadolescent soccer players and results indicate that plyometric training improved speed (30 m sprint) in soccer players. Two studies tested the benefits of plyometric training on the agility of volleyball

players in both sexes. In a study conducted over eight weeks in under-15 women, it was observed that performance at in a shuttle run (6 m ⇥ 6 m) was significantly improved (by 0.7 s) [Lehnert et al., 2009]. In a longer intervention (12 weeks) conducted in young adult men, it was also found that participants' agility in a 50 m shuttle run was meaningfully improved, as the times to complete the shuttle run decreased from 14.15 to 12.86 s for participants who wore a weighted vest and from 14.51 to 13.97s for participants who did not wear a weighted vest [Velickovic et al., 2017].

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 a 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 hard 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 impact of plyometric training on different surfaces on speed and agility performance of male volleyball players.

Methods and Procedures

The purpose of the study was to find out the impact of plyometric training on different surfaces on speed and agility 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	60%	2	4
	• 15 Mts Alternate Leg Bound		2	4
	• 15 Mts Double Leg Box Bound		2	4
	• 15 Mts Double Leg Pace Hop		2	4
	• 15 Mts Single Leg Pace Hop		2	4
	• 15 Mts Side Hop		2	4
	• 15 Mts Squat Jump		2	4
	• 15 Mts Knee-Tuck Jump		2	4
	• 15 Mts Split Jump		2	4
	• 15 Mts Side Jump		2	4
V -VIII Week	• 20 Mts Double Leg Bound	65%	3	4
	• 20 Mts Alternate Leg Bound		3	4
	• 20 Mts Double Leg Box Bound		3	4
	• 20 Mts Double Leg Pace Hop		3	4
	• 20 Mts Single Leg Pace Hop		3	4
	• 20 Mts Side Hop		3	4
	• 20 Mts Squat Jump		3	4
	• 20 Mts Knee-Tuck Jump		3	4
	• 20 Mts Split Jump		3	4
	• 20 Mts Side Jump		3	4

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

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	60%	**2**	**4**
	• 15 Mts Alternate Leg Bound		**2**	**4**
	• 15 Mts Double Leg Box Bound		**2**	**4**
	• 15 Mts Double Leg Pace Hop		**2**	**4**
	• 15 Mts Single Leg Pace Hop		**2**	**4**
	• 15 Mts Side Hop		**2**	**4**
	• 15 Mts Squat Jump		**2**	**4**
	• 15 Mts Knee-Tuck Jump		**2**	**4**
	• 15 Mts Split Jump		**2**	**4**
	• 15 Mts Side Jump		**2**	**4**
V -VIII Week	• 20 Mts Double Leg Bound	65%	**3**	**4**
	• 20 Mts Alternate Leg Bound		**3**	**4**
	• 20 Mts Double Leg Box Bound		**3**	**4**
	• 20 Mts Double Leg Pace Hop		**3**	**4**
	• 20 Mts Single Leg Pace Hop		**3**	**4**
	• 20 Mts Side Hop		**3**	**4**
	• 20 Mts Squat Jump		**3**	**4**
	• 20 Mts Knee-Tuck Jump		**3**	**4**
			3	**4**

	• 20 Mts Split Jump • 20 Mts Side Jump		**3**	**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 • 25 Mts Side Jump	70%	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**	**4** **4** **4** **4** **4** **4** **4** **4** **4** **4**

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 Speed And Agility Of Experimental And Control Groups

VARIABLES		**PTSSG**	**PTWSG**	**CG**	**SOV**	**SS**	**df**	**MS**	**F- ratio**
Speed	Pretest Mean	7.15	7.16	7.15	B	0.001	2	0.001	0.03
	SD	0.15	0.10	0.11	W	0.671	42	0.016	
	Post test Mean	6.71	6.90	7.14	B	1.38	2	0.69	22.12*
	SD	0.12	0.26	0.10	W	1.31	42	0.031	
	Adjusted Post test Mean	6.71	6.90	7.14	B	1.39	2	0.69	24.30*
					W	1.17	41	0.029	
Agility	Pre test Mean	11.31	11.32	11.33	B	0.004	2	0.002	0.07
	SD	0.27	0.09	0.05	W	1.26	42	0.030	
	Post test Mean	10.40	10.68	11.30	B	6.38	2	3.19	103.31*
	SD	0.18	0.21	0.10	W	1.29	42	0.031	
	Adjusted				B	6.36	2	3.18	

	Post test Mean	10.40	10.68	11.30	W	1.29	41	0.032	100.68*

The adjusted post test mean values on speed of PTSSG, PTWSG and CG were 6.71, 6.90 and 7.14 respectively. The obtained 'F' ratio of 53.3 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 speed. The results of the study indicated that there was significant difference between the adjusted post test means of EITG, IITG and CG on speed.

The adjusted post test mean values on agility of PTSSG, PTWSG and CG were 10.40, 10.68 and 11.30 respectively. The obtained 'F' ratio of 100.68 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 agility. The results of the study indicated that there was significant difference between the adjusted post test means of PTSSG, PTWSG and CG on agility.

Table – 4 Scheffe's Post Hoc Test For The Adjusted Post-Test Paired Means

Difference On Speed And Agility

	Adjusted Post-Test Means			Mean difference	Confidence Interval
	PTSSG	**PTWSG**	**CG**		
SPEED	6.90	6.71		0.17*	0.15
	6.90		7.14	0.24*	0.15
		6.71	7.14	0.43*	0.15
AGILITY	10.68	10.40		0.28*	0.16
	10.68		11.30	0.62*	0.16
		10.40	11.30	0.90*	0.16

***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 0.17, 0.24 and 0.43 for speed and 0.28, 0.62 and 40.90 for agility respectively. They were greater than the confidence interval value of 0.15 and 0.16 at 0.05 level which indicate that the twelve weeks of plyometric training on sand surface and plyometric training on wooden surface groups have significantly increased speed and agility as compared to the control group. The result also reveals that the increase in speed and agility are significantly improved for plyometric training on wooden surface group as compared with plyometric training on sand surface group.

Discussion on Finding

The result of present study was that speed and agility 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 speed and agility were significantly more for the PTWSG than the PTSSG 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. Lohith and Prakash, (2019) have proved that plyometric training on sand surface significantly increase speed, agility and explosive power. Ahmadi et al., (2021) have found that significant interaction was also observed 8

weeks of plyometric jump training (PJT) conducted on sand or a rigid court surface on jump-related and CMJ height; CMJ rate of force development (RFD); CMJ velocity at take-off; DJ height and CMJ peak force), 20 m linear sprint time, t test for change-of-direction sprint (CODS) time, in female indoor volleyball players. Binnie et al., (2013) have found that significant improvement in 20-m sand time in the sand group only ($p < 0.05$), whereas 20-m grass time improved equally in both training subgroups ($p < 0.05$). Hemambara and Maniazhagu (2015) The results clearly show there was a significant difference among the low intensity aquatic plyometric training (LI-APT) and low intensity land plyometric training (LI-LPT) on speed. 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. Manoj Kumar et al., (2021) have concluded that both the surfaces are able to enhance the performance of football players. While comparing the groups sand surface plyometric training was found more effective than grass surface training in reference with cardiovascular endurance, explosive power and speed while agility was equally improved in both the groups. Thus both the surfaces can be used as an alternative to increase agility. Ozen et al., (2020) have concluded suggest that while the plyometric training performed on a wooden or sand surface does not cause a different effect on the improvement of jumping performance, plyometric training on the sand surface may be a more effective training surface to improve the agility and sprint performance of young players. 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. Nagaraja and Gajanana Prabhu, (2017) have concluded that the speed aspect of speed, dynamic strength, lower body explosiveness, agility can be significantly enhanced through sand based plyometric training as compared to land based plyometric training.

Pereira et al., (2023) have concluded sprint-jump training programmes performed on both grass and sand surfaces elicited significant improvements in curve sprint and change-of-direction performances, whereas acceleration and linear sprint velocity increased only in the sand group, after a short-term training period. The sand training surface was proven to be a practical strategy to improve sprint performance in all its forms in soccer players, which is of great interest and importance for coaches and sport scientists working in elite soccer. 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. Sathishkumar, (2011) have concluded that six weeks of sand training significantly improved the selected dependent variables such as speed, agility, endurance, resting pulse rate, breath holding time and blood pressure than offshore training among inter engineering college football players. Senthil Kumar et al., (2016) have concluded that aquatics plyometric may be as good or better for improving speed and long jump performance as a land plyometric training. Bonavolonta et al., (2021)) have found that 7-week plyometric training performed on sand showed significant improvement on sprinting, jumping and balance respect to the same training performed on grass surface in adult soccer players. 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. Jacob, (2010) have concluded that significant improvement on speed, endurance, agility and flexibility due to the influence of six weeks of sand and seashore training. It was also concluded that there was no significant improvement on volleyball playing ability due to six weeks of sand and seashore training. Nisith and Rakesk., (2015) have proved that result of the study indicates due to Aquatic and Land plyometric training on speed, explosive power, and agility has been improved significantly. Kamalakkannan et al., (2010) have concluded land and aquatic training group showed significant improvement on the speed, endurance and explosive power variables. 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.

Conclusions

The analysis of data revealed significant improvement on speed and agility 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 speed and agility were significantly more for the PTWSG than the PTSSG volleyball players.

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