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Effect of plyometric training with dynamic stretching programme on Explosive power and Agility of female volleyball players

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Abstract
The purpose of the study was to compare, analyze the individual and combined effect of plyometric training program and dynamic stretching on Explosive power and Agility. The subjects included 60, healthy female collegiate volleyball players between the ages of 18–25. All the subjects were tested in using Explosive power test and Agility test respectively prior to starting the dynamic stretching and plyometric training program. The subjects then completed a 8 week training program and were re tested. The subjects in each of the training groups trained for 2 days per week, whereas control group did not participate in any training activity. The data were analyzed by an anova [ANOVA] and analysis of co-variance [ANOCOVA]. The results showed that all the training treatments elicited significant (P<0.05) improvement in all of the tested variables. The combined plyometric training with Dynamic stretching group showed significantly greater improvement in Explosive power and Agility, whereas plyometric training group and dynamic stretching group showed lesser improvement in Explosive power and Agility. This study provides support for the use of plyometric drills and dynamic stretching exercises to improve the Explosive power and Agility.

Keywords: Explosive power and Agility, plyometric training and dynamic stretching and volleyball.

1. Introduction

The new offense and defense playing roles to brought a need for an intensive study of volleyball abilities, especially the ability of the leg muscles to produce explosive type strength which on terminology referred to as vertical jump. The spiking and blocking are dominated by the corresponding explosive type strength. Abilities such as the standing linear jump as well as high speed shift in space at short distances are also included for the top volleyball players as model characteristics apart from the anthropometric measurements (S.J. Seabourne, *et al*., 1980) [1].

The height of the volleyball players cannot be changed but, the height within reach during a spike or block can be increased at eh course of training. To “build” explosive strength “into” not only the biochemical structure, but also many other structures of volleyball techniques (KOSTIC, 1995). In the concept of explosive type strength connected with the reactive abilities of the neuromuscular apparatus. Plyometrics is a speed – strength training, a combination of strength and speed (Gunsoo Han, *et al*., 2010).

Plyometric training can contribute to improvements in vertical jump performance, acceleration, leg strength muscle power, increased joint awareness and overall proprioception. plyometric training involves powerful muscular contractions in response to a rapid stretching of the involved musculature. It is a rapid pre stretching of a muscle during an eccentric action, followed immediately by a concentric action of same muscle and connective tissue. The sequence of events is known as “stretch shortening cycle” (Morkovic, *et al*, 2007). The idea behind plyometric training is the use explosive movements to develop muscular power, the ability to generate a large amount of force quickly.

Stretching of the specific muscles to be used in the subsequent activities are used to achieve a short-term increase in the ROM at a joint or induce muscle relaxation and decrease the stiffness of the muscle-tendon system (Ellenbecker. T, 2002). Rehearsal of the skill about to be performed is incorporated into the warm-up at increasing intensities so that the specific muscle fibers and neural pathways are activated and recruited for optimum performance. This type of stretch involves an agonistic muscle contracting, while the opposite antagonistic muscle relaxes, decreasing excitatory impulses through the nervous system to the motor units (reciprocal inhibition). Therefore, in a complex movement pattern (such as sprinting) where muscle pairs need to work in conjunction, one set of muscles may be in a position of being 'switched off', through a decrease in nervous system stimuli.(Byungjun, *et al*., 2010)

2. Methods

2.1 Selection of subjects

The subjects who met the inclusion criteria were assigned to four groups. Group I included 15 subjects who performed the plyometric training, Group II included 15 subjects who performed the dynamic stretching, Group III included 15 subjects who performed combined plyometric training with dynamic stretching and Group IV did not participated in any of the activities. Subjects were selected from SNS group of institutions. Healthy females within the age group of 18 – 25 years playing volleyball at college level were included for the study.

2.2 Training Program

Before the initiation of the training periods, the subjects of all groups were instructed about the proper execution of all the exercises to be used during the training period for all training regimens. During the training period, Group I underwent 30 minutes of plyometric training programme on Mondays and Thursdays, Group II underwent 20 minutes of Dynamic

stretching programme on Tuesdays and Fridays, Group III underwent 35 minutes of plyometric training programme and dynamic stretching programme on Wednesdays and Saturdays. The subjects of the three training groups participated two days a week for 8 weeks. Group IV acted as a control group that did not participate in any special training programme.

2.3 Testing Procedures

Explosive power was measured by using Sergeant Jump test and the score was recorded in centimeters. Agility was measured by using Illionosis agility run test and the score was recorded in seconds. The above test was measured before and after 8 weeks training period.

3. Statistical Analysis

In order to analyze the significant changes made from the base line on all the groups individually dependent't' test was applied. Analysis of Co – Variance was applied to determine the significant difference among the treatment means on each variable. The significance differences of pairs of adjusted final group means were tested by applying Scheffe's post hoc test. The significance of the means of the obtained test results at 0.05 level of confidence. The data were analyzed by using SPSS software analysis

Table 3.1: Results of the Pretest and Posttest of Explosive power and Agility for plyometric training group

Variables	Group	Mean ±SD	Mean Differences	SEM	't' ratio	%
Explosive power	Pre test	24.80 ± 1.14	2.53	0.23	10.72*	10.22
	Post test	27.33 ± 1.44				
Agility	Pre test	18.51 ± 0.99	1.37	0.17	7.74*	7.41
	Post test	17.14 ± 0.85				

*Significant at 0.05 level

Table 3.1 indicates the obtained 't' values of the plyometric training group on variables of: 10.72 (Explosive power) and 7.74 (Agility). The obtained t- values to be significant at 0.05 level for degree of freedom 1, 19 the required critical value was 2.09. Hence the obtained t-values on the selected criterion variables higher than the required critical values, it was concluded that the plyometric training programme produced significant improvement in Explosive power (10.22%) and Agility (7.41%).

Table 3.2: Results of the Pretest and Posttest of Explosive power and Agility for Dynamic stretching group

Variables	Group	Mean± SD	Mean Differences	SEM	't' ratio	%
Explosive power	Pre test	24.86 ±1.35	1.46	0.21	6.81*	7.68
	Post test	26.33±1.29				
Agility	Pre test	18.53 ±0.90	0.61	0.08	7.63*	4.65
	Post test	17.92±0.98				

*Significant at 0.05 level

Table 3.2 indicates the obtained't' values of the dynamic stretching group on variables of: 6.81 (Explosive power) and 7.63 (Agility). The obtained t- values to be significant at 0.05 level for degree of freedom 1, 19 the required critical value was 2.09. Hence the obtained t-values on the selected criterion variables higher than the required critical values, it was concluded that the Dynamic stretching program produced significant improvement in Explosive power (7.86%) and Agility (4.65%).

Table 3.3: Results of the Pretest and Posttest of Results of the Pretest and Posttest of Explosive power and Agility for plyometric training with dynamic stretching group

Variables	Group	Mean ±SD	Mean Differences	SEM	't' ratio	%
Explosive power	Pre test	24.60 ± 0.98	3.46	0.23	14.67*	14.09
	Post test	28.06 ± 1.53				
Agility	Pre test	18.53 ± 0.92	1.68	0.20	8.30*	9.10
	Post test	16.84 ± 1.25				

*Significant at 0.05 level

Table 3.1 indicates the obtained't' values of the plyometric training with dynamic stretching group on variables of: 14.67 (Explosive power) and 8.30 (Agility). The obtained t- values to be significant at 0.05 level for degree of freedom 1, 19 the required critical value was 2.09. Hence the obtained t-values on the selected criterion variables higher than the required critical values, it was concluded that the plyometric training with dynamic stretching programme produced significant improvement in Explosive power (14.09%) and Agility (9.10%).

Table 3.4: Results of the Pretest and Posttest of Results of the Pretest and Posttest of Explosive power and Agility for control group

Variables	Group	Mean ±SD	Mean Differences	SEM	't' ratio	%
Explosive power	Pre test	24.66±1.34	0.40	0.19	2.10*	1.62
	Post test	25.06±1.48				
Agility	Pre test	18.58±0.94	0.02	0.02	1.17*	0.10
	Post test	18.55±0.98				

Table 3.3 indicates the obtained't' values of the dynamic stretching group on variables of: 2.10 (Explosive power) and 1.17 (Agility). The obtained t- values to be significant at 0.05 level for degree of freedom 1, 19 the required critical value was 2.09. Hence the obtained t-values on the selected criterion variables lesser than the required critical values, it was concluded that it produced insignificant improvement in Explosive power (1.62%) and Agility (0.10%).

Table 3.5: Analysis of Variance on Pre-Test

Variables	Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Explosive power	Between Groups	.667	3	.222	.15
	Within Groups	83.067	56	1.483	
Agility	Between Groups	.036	3	.012	.013
	Within Groups	49.788	56	.889	

Table 3.5: Analysis of Variance on Post-Test

Variables	Source of variation	Sum of squares	Degrees of freedom	Mean square	F
Explosive power	Between Groups	76.067	3	25.356	12.18*
	Within Groups	116.533	56	2.081	
Agility	Between Groups	26.832	3	8.944	8.43*
	Within Groups	59.432	56	1.061	

*Significant at 0.05 level

4. Results

Analysing the Significance of Mean Difference on Criterion Variables

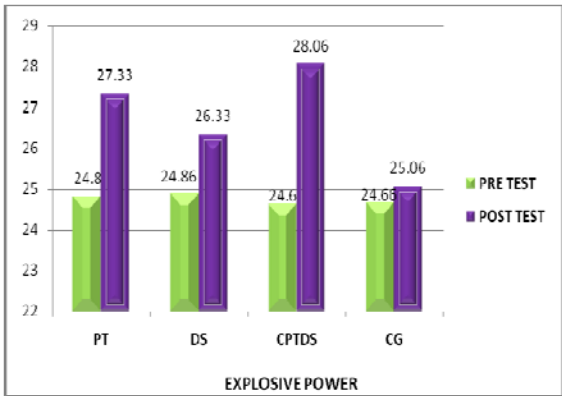
In analysis of covariance, analyzing the data on pretest means and posttest means among the Plyometric training group, Dynamic stretching group and Plyometric training with Dynamic stretching group is the preliminary process. As the final step of analysis of covariance, the posttest means are adjusted for differences in the pretest means, and the adjusted means are tested for significance. Thus the data were analyzed and the results on pretest, posttest and adjusted test are as follows.

Results on Pretest means

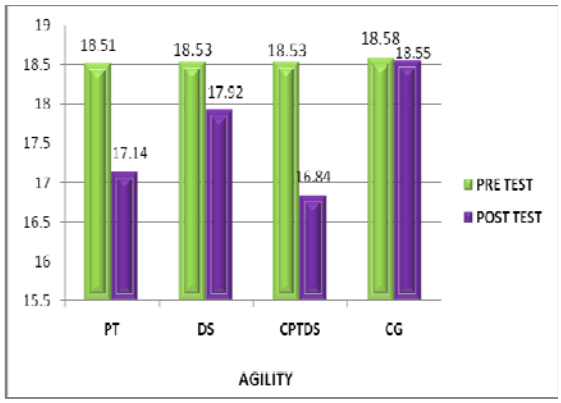
In testing the pretest means among Plyometric training group, Dynamic stretching group, Plyometric training with Dynamic stretching group and control group on criterion variables, the obtained f-ratios are: 15 (Explosive power) and .013 (Agility). The obtained F-ratios were statistically not significant since they failed to reach the critical value (3.16) at 0.05 level. Thus the obtained results on pretest mean confirm the random assignment of subjects in to different groups was successful.

Results on Posttest means

In testing the posttest means among Plyometric training group, Dynamic stretching group, Plyometric training with Dynamic stretching group and control group on criterion variables, the obtained f-ratios are: 12.18 (Explosive power) and 8.43(Agility). The obtained F- ratios were found as statistically significant on Explosive power and Agility.



Bar diagram showing Pretest and Posttest means of PT, DS, CPTDS & CG on Explosive power



Bar diagram showing Pretest and Posttest means of PT, DS, CPTDS & CG on Agility

Table 3.6: Analysis of Co Variance on Adjusted Post Test Means

Variables	Source of variation	Sum of squares	Degrees of freedom	Mean squares	F
Explosive power	Between Groups	78.930	3	26.310	35.60*
	Within Groups	40.638	55	.739	
Agility	Between Groups	25.367	3	8.456	28.20*
	Within Groups	16.490	55	.300	

Results on Adjusted means

In testing the adjusted means among Plyometric training group, Dynamic stretching group, Plyometric training with Dynamic stretching group and control group on criterion variables, the obtained f-ratios are:, 35.60(Explosive power) and 28.20 (Agility). The obtained F- ratios on the above said criterion variables among the three groups were significant at 0.05 level. Thus the obtained results on adjusted means statistically confirm the differences exist after completion of treatment period on criterion variables among Plyometric training group, Dynamic stretching group, Plyometric training with Dynamic stretching group and control group.

5. Discussion and Conclusion

This study is an attempt to investigate that whether dynamic stretching is a useful addition to plyometrics for the players who require repetitive jumping activity. These functional adaptations were reflected in significant increases in both the variables. The subjects may attain the maturity level, as also been suggested as a prerequisite to be consider prior to the administration of the plyometrics, that the participant has reached a basic maturation level, adequate strength, with proper balance and functional strength. However there has been limited research examining the influence of plyometric training with dynamic stretching exercises.

5.1 Discussion on Explosive power

The Sergeant vertical jump test was used to measure explosive power. The plyometric training group, dynamic stretching group and plyometric training with dynamic stretching group significantly improved explosive power from baseline to post training. The increased explosive power in the plyometric training group from pre (24.8) to post (27.33); dynamic stretching group from pre (24.86) to post (26.33); and plyometric training with dynamic stretching group from pre (24.6) to post (28.06). The explosive power significantly improved from pre to post on all the three groups. This indicates that means differences between pre- and post-tests were in favor of post-tests. Hence the explosive power had improved significantly after 12 weeks of training. Whereas the control group did not shows any significant improvement on explosive power.

According to John Shaji *et al*., the result demonstrates that the vertical jump height readings for the Sergeant jump test was improved by 4.8 cm (10.2%) in the Group-A which underwent dynamic stretching and 3.6 cm (7.9%) in the Group-B which underwent plyometrics. The findings of Dr. Ranel (2011) showed that the plyometric training was highly significant (p<0.01) improvements in the Sergeant vertical jump. Plyometric training might be a functionally superior training modality for players. The study Lue-Chin P (2010) showed that at the end of the three weeks of plyometric training program, there were significant improvements in Vertical Jump Scores (p = 0.023). Alying Ozge (2010) did a study to determine the effect of 4 months volleyball training on jump concluded that training significantly affected subjects jumping performance & were significantly improved. Vertical jump height was significantly higher following the dynamic warm up protocol compared to the static warm up protocol. Vertical jump scores (m) were 0.276±0.04, 0.254±0.03. These results indicate that an acute dynamic warm up can enhance fitness performance in activities that require a high power output whilst maintaining joint range of motion. In the findings of Samir Lotfy El-Sayed (2010) there is an improvement in jump height was by 12.58% for volleyball players.

5.2 Discussion on Agility

The Illionosis agility test were used to measure agility. The plyometric training group, dynamic stretching group and plyometric training with dynamic stretching group significantly improved agility from baseline to post training. The increased agility in the plyometric training group from pre (18.51) to post (17.14); dynamic stretching group from pre (18.53) to post (17.92); and plyometric training with dynamic stretching group from pre (18.53) to post (16.84). The agility significantly improved from pre to post on all the three groups. This indicates that means differences between pre- and post-tests were in favor of post-tests. Hence the agility had improved significantly after 12 weeks of training. Whereas the control group did not shows any significant improvement on agility.

The plyometric training group improved their Illinois Agility Test times by −0.50±0.32 sec (Michael G. Miller, 2006). According to John Shaji *et al*., the result demonstrates that the agility readings for the T- test was improved by 5.12% in the Group-A which underwent dynamic stretching and 6.20% in the Group-B which underwent plyometric training and 10.67% in the Group- C which underwent combination of dynamic stretching and plyometric training program. The findings of McMillian *et al*. (2006) where the effect of static stretching versus dynamic stretching on power and agility were found to be significant in agility scores following dynamic stretching. There was an overall improvement in agility score by 6.20% which received plyometric training program is consistent with the result of a study of 6 weeks of plyometric training on agility by Michael G. Miller *et al*. The results are improved because of better motor recruitment or neural adaptations. The 4 months volleyball training for volleyball players was significantly improved in agility performance about 8.84% at (p<0.05) level of significance. (Pekel Haci Ahmet *et al*., 2010).

5.3 Conclusion

The present study revealed that an increase in explosive power of 10.22% in plyometric training group, 5.90% in dynamic stretching group and 14.09% in plyometric training with

dynamic stretching group and increase in agility of 7.41% in plyometric training group, 3.31% in dynamic stretching group and 9.10% in plyometric training with dynamic stretching group. Between groups analyses showed pre- to post training increase in agility to be significantly (P<0.05) higher in CPTDS programme compared with the PT, DS and CG programme.

Therefore, plyometrics is recommended to be incorporated prior to dynamic stretching when the vision is to enhance the Explosive power and Agility. Plyometric training and volleyball go together if the player want to reach their full potential. Not only with volleyball, but with any sport, the correct training will help to achieve your goals. Plyometric exercises are designed to do is improve the functions of the nervous system. Performing dynamic stretches increases the core and muscle temperature, stimulates the nervous system, and improves elasticity. It helps to produce fast and powerful movements. So that this study is naturally related to the variables which was focussed. It is greatly helps in the improvement of Explosive power and Agility. The findings suggested that 2 days of plyometric training with dynamic stretching a week for 8 week is sufficient enough to show improvement in Explosive power and Agility.

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