International Journal of Physical Education, Vol. 4 No. 1 (April, 2011) : 41-44

Research Paper :

Effect of plyometric training with and without weight jacket on elastic strength and explosive power

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Received : *January, 2011;* **Accepted :** *February, 2011*

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ABSTRACT

The purpose of this paper was to enhance the sports performance with the objective is to analyse the plyometric training with and without weight jacket on elastic strength and explosive power. To achieve this, thirty nine physically active and interested students (N = 39) were selected as subjects and their age group ranged between 18 and 24 years. The subjects were categorized into three groups randomly. Group I plyometric training with weight jacket (PTWWG), group II plyometric training without weight jacket (PTWOWG), group III control group (CG) and each group comprised of thirteen subjects (N = 13). Both experimental groups underwent their respective experimental treatment for twelve weeks, 3 days per week and a session on each day. Control group was not exposed to any specific training. Elastic strength and explosive power were taken as variables for this study. The collected data were analysed using analysis of covariance (ANCOVA) and Scheffe's post hoc test. The results revealed significant difference in all the selected strength variables (P £ 0.05) among PTWWG and PTWOWG pointing towards the use of plyometric training for performance improvement.

Abraham, George (2011). Effect of plyometric training with and without weight jacket on elastic strength and explosive power. *Internat. J. Phy. Edu.*, **4** (1) : 41-44.

Key words : Plyometric training, Elastic strength, Explosive power

Plyometrics is a type of exercise training designed to produce fast, powerful movements and improve the functions of the nervous system, generally for the purpose of improving performance in sports – plyometric movements, in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscles and surrounding tissue to jump higher and run faster, depending on the desired training goal (Goran *et al*., 2007). It is used to increase the speed or force of muscular contractions, providing explosiveness for a variety of sport specific activities. This training involves and uses, practicing plyometric movements to toughen tissues and train nerve cells to stimulate a specific pattern of muscle contraction, so the muscles generate as strong a contraction as possible in the shortest amount of time. A plyometric contraction involves first a rapid muscle lengthening movement (eccentric phase), followed by a short resting phase (amortization phase), then an explosive muscle shortening movements (concentric phase), which enable muscles to work together in doing the particular motion. This training engages the myotactic reflex, which is the automatic contraction of muscles when their stretch sensory receptors are stimulated. Some plyometric exercises are used to perform this study for strengthening the lower body and upper body and these are 1. Drop jump, 2. Tuck jump, 3. Split jump, 4. Bounding, 5. Single leg hop, 6. Hurdling, 7. Medicine-ball exercises. Plyometric exercises with additional weights have been used successful by many athletes as a method of training to enhance power (Andrew, 2010). In order to realize the potential benefits of plyometric training, the stretch shortening cycle must be involved. The rate of stretch rather than the magnitude of stretch are of primary importance in plyometric training and the coupling time or ground contact time must be as short as possible.

Elastic strength is the ability to exert force quickly and to overcome resistance with a high speed of muscle action. High level le elastic strength requires good coordination and a combination of high speed and strength of muscle action. It is important in explosive activities such as jumping and sprinting. Plyometric exercises with weights are the best method to improve elastic strength. Explosive power is the ability to expand energy in one explosive act or in a serious of strong sudden movements in jumping (Dodd and Alvar, 2007). In this action, the neuromuscular system to overcome resistance with high speed of contraction when the skeletal lever system accepts and expels at high velocity *viz;* a coordination of motor units, reflexes, elastic component and contractile component of the muscle. Plyometric training helps to develop the contractile protein that gives the muscle in pulling power (Edwin and Gordon, 2010). The jumpers need great leg strength and power while jumping; the explosive power mainly depends upon one's leg strength. In this study standing broad jump was used as a test to measure the explosive power and it was improved through explosive training with the support of weight jacket.

METHODOLOGY

To achieve this, thirty nine (N = 39) physically active and interested students of Annamalai University were randomly selected as subjects and their age ranged between 18 to 24 years. The subjects were categorized into three groups randomly: Group I plyometric training with weight jacket group (PTWWG), group II plyometric training without weight jacket group (PTWOWG), group III control group (CG) and each group had thirteen (N = 13) subjects. Elastic strength and explosive power were selected as variables for this study. The elastic strength data were measured by using five stride bounding and the explosive strength was measured by using standing broad jump. Control group was not exposed to any training. Both experimental groups underwent their respective experimental treatment for 12 weeks, 3 days per week and a session on each day. The subjects were instructed to wear a weight jacket which was filled with sand in 3 kg and 5 kg weights for PTWWG group and they had been given 3 kg weight for first six weeks and increased load of 5 kg for last six weeks. The PTWWG and PTWOWG initially performed thorough warming up exercises. After that both the groups performed the following plyometric exercises: 1. Drop jump, 2. Tuck jump, 3. Split jump, 4. Medicine-ball exercises, 5. Bounding, 6. Single leg hop (alternative leg) and 7. Hurdling. These exercises were performed for 90 minutes in a day. Observations were made for 12 weeks and then post test data were taken.

Data analysis:

Mean and standard deviation were calculated for elastic strength, explosive power for each training group. Analysis of covariance (ANCOVA) and Scheffe's post hoc tests were used to examine the significance between the variables for testing groups (PTWWG, PTWOWG and CG). The analysis was carried out using SPSS version and the statistical significance was set to a priority at $p < 0.05$.

OBSERVATIONS AND DISCUSSION

The findings of the present study as well as relevant discussion have been summarized under following heads:

Elastic strength:

The analysis of covariance on elastic power of the pre, post and adjusted post mean scores of plyometric training combined with weighed vest, plyometric training without weight jacket and control groups have been analysed and presented in Table 1. The table indicates the pre and post test mean and standard deviation of experimental and control groups on elastic strength. The obtained 'F' value for pre test mean on elastic strength was 0.18, which was lesser than table value of 3.26 at 0.05 level of confidence, hence there was no significant difference in pre test data of experimental and control groups. The analysis of post and adjusted post test mean data revealed the 'F' value of 49.14 and 50.29, respectively, which was higher than table 'F', hence there existed difference in elastic strength among the experimental and control groups. Since, three groups were compared, whenever the obtained 'F' ratio for adjusted post test was find to be significant, the Scheffe's test was used to found out the paired mean difference which is presented in Table 2.

Table 1: Analysis of covariance for elastic strength of experimental and control groups

Test	PTWWG	PTWOWG	CG	SOV	SS	df	MS	F
Pre-test								
Mean	9.76	9.84	9.84	B G	0.06	2	0.03	0.18
S.D. (±)	0.40	0.40	0.40	W G	5.80	36	0.16	
Post-test								
Mean	11.02	10.71	10.25	B.G	3.82	2	1.92	49.14*
S.D. (±)	0.26	0.91	0.11	W G	1.40	36	0.04	
Adjusted post-test								
Mean	11.01	10.71	10.26	B G	3.70	2	1.85	50.29*
				W G	1.29	35	0.04	

*Significant F = (df 2, 36) (0.05) = 3.26 & (df 2, 35) (0.05) = 3.27; ($p \leq 0.05$)

Table 2: Scheffe's post hoc test for the difference between paired mean on elastic strength

PTWWG	PTWOWG	CG	MD	CI
11.01	10.71		0.30*	
11.01		10.26	0.75	0.19
	10.71	10.26	0.45*	

*indicates significance of value at P ≤ 0.05

The result of the study showed that there was a significant difference between experimental groups and control group and also significant difference between two experimental groups. The pre, post and adjusted post mean values of experimental groups and control group on elastic strength were graphically represented in the Fig. 1.

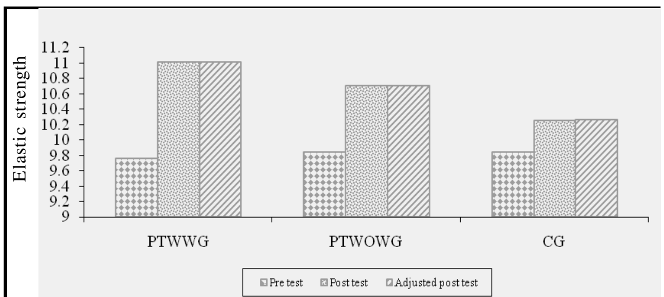

Fig. 1: The pre, post and adjust post test mean values of experimental groups and control group on elastic strength

Explosive power:

The analysis of covariance on explosive power of the pre, post and adjusted post mean scores of plyometric training combined with weighed vest, plyometric training without weighed vest and control groups were analysed and presented in Table 3. The table indicates the pre and pots test mean and standard deviation of experimental and control groups on explosive power. The obtained 'F' value for pre test mean on explosive power was 2.47, which was lesser than table value of 3.26 at 0.05 level of confidence; hence there was no significant difference in pre test data of experimental and control groups. The analysis of post and adjusted post test mean data revealed that 'F' value of 40.12 and 113.92, respectively, were higher than table 'F', hence there existed difference in explosive strength among the experimental and control groups. Since, three groups were compared, whenever the obtained 'F' ratio for adjusted post test was found to be significant, the Scheffe's test was applied to in out the paired mean difference and it is presented in Table 4.

Table 4: Scheffe's post hoc test for the difference between paired mean on explosive power

SWOEG	SWEG	CG	Mean Difference	CI
2.57	2.51		0.06*	
2.57		2.27	0.30*	0.05
	2.51	2.27	0.24*	

*indicates significance of value at P ≤ 0.05

The result of the study showed that there was a significant difference between experimental groups and control group and also significant difference between two experimental groups. The pre, post and adjusted post mean values of experimental groups and control group on explosive power have been graphically represented in the Fig. 2.

This study clearly established that there was no significant difference among the groups in pre test mean in elastic strength and explosive power. It also indicated that there was a significant difference in post and adjusted post test mean among the groups in elastic strength and explosive power. The current study utilized 12-weeks programme duration with two sessions per week and found that both plyometric trainings with weighed vest and without weighted vest elicited an increase in elastic power and explosive power. Several studies suggested that

Table 3: Analysis of covariance for explosive power of experimental and control groups

Test	PTWWG	PTWOWG	CG	SOV	SS	df	MS	F
Pre-test								
Mean	2.31	2.22	2.23	B G	0.06	2	0.029	2.47
S.D. (±)	0.12	0.11	0.10	W G	0.43	36	0.012	
Post-test								
Mean	2.61	2.48	2.25	B G	0.87	2	0.43	40.12*
S.D. (±)	0.12	0.11	0.07	W G	0.39	36	0.011	
Adjusted Post-test								
Mean	2.57	2.51	2.27	B G	0.63	2	0.31	113.92*
				W G	0.10	35	0.003	

*Significant F = (df 2, 36) (0.05) = 3.26 & (df 2, 35) (0.05) = 3.27, p ≤ 0.05.

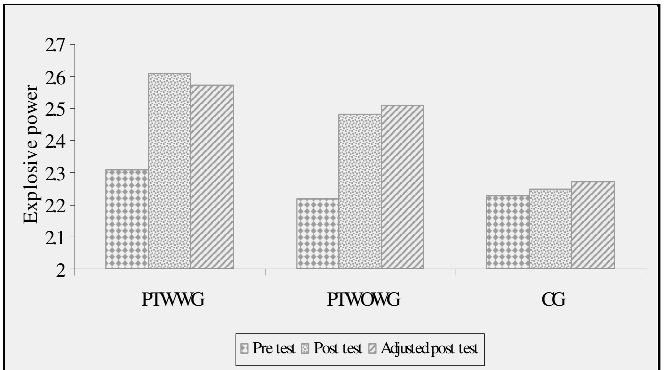

Fig. 2: The pre, post and adjust post test mean values of experimental groups and control group on explosive power

plyometric training is very valuable for determining the variables such as elastic strength and explosive power (Andrew *et al.,* 1996). These results are concurred with the previous studies (utilising training duration between 4 to 24 weeks and various session frequencies), which were found plyometric training with the support of weights to improve elastic strength and explosive power performance (Riadh *et al.,* 2010). In particular plyometric training with weight vest which reported maximum increase plyometric training with weight vest reported maximum increase in elastic strength and explosive power performance of male students. The development of elastic power and explosive power as result is supported by the findings of Roger *et al.*, (2007). Finally Andrew (2010) reported increase in elastic strength and explosive power performance after 12 weeks plyometric training. The present findings provide further support to the notion that plyometric training can demonstrate benefits in a short period of time, indicating that twenty four sessions of plyometric training suffice for initial improvements. Similar to the above studies, the subjects of the current study were well-trained competitive athletes rather than untrained individuals, highlighting further the effectiveness of plyometric training in improving the elastic strength and explosive power.

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