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Effect of varied intensity of plyometric training on explosive strength and resting heart rate among college women volleyball players

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Abstract
The purpose of the study was to find out the effects of varied intensity of Plyometric training on selected motor fitness and physiological variables among college women volleyball players. To achieve the purpose of this study, sixty (N=60) women volleyball players were selected from different colleges of Andhra Pradesh who represented their colleges in intercollegiate level volleyball tournaments. The selected subjects were of age group ranging from 19 to 24 years with standard deviation of ± 2.1. The subjects were randomly divided into four groups and each group contained fifteen subjects. Group I acted as experimental group I and Group II acted as experimental group II group III acted as experimental group III and the fourth group was considered as control group. Pre test scores were obtained using standard tests on selected motor fitness and physiological variables, such as explosive strength and resting heart rate before the experimental period and the post test scores were obtained immediately after the twelve weeks experimental period. The difference between the pre test and post test means were subjected to statistical treatment using ANCOVA, which was the effect of varied intensities of plyometric training. In all cases 0.05 levels was fixed to test of the study.

Keywords: Physiological and motor fitness abilities, strength, volleyball players

Introduction
Physical Education may be defined as education through the physical activities where many of the educational objectives are achieved by means of big muscle play activities. It is a vital phase of education and an integral part of the total education process. (Robert (2007)
The vital phase of education that is physical education, aims at all round development of an individual where the medium of achieving the goal is physical activity. Hence it is through the big muscle – play activity – an individual can enlighten the personality traits such as physical fitness, emotional balance and social behavior etcetera besides intellectual development.

Objectives of the study
The main objective of this study was to frame different intensities of Plyometric training, after classification of intensities, such as, low, medium and high, the investigator would administer the Plyometric training with varied intensities on the subjects for a period of twelve weeks.
- To formulate different intensities of plyometric training for the benefit of college level volleyball players.
- To measure selected motor fitness and physiological variables of college level volleyball players.
- To experiment with different intensities of plyometric training for 12 weeks and compare the effect with control group.
- To determine which of the intensity of plyometric training, whether low or medium or high beneficially alter selected motor fitness and physiological variables of college level volleyball players.

Statement of the problem
The purpose of this study was to find out the Effect of Varied Intensity of Plyometric Training on Explosive Strength and Resting Heart Rate among College Women Volleyball Players

Hypothesis
- It was hypothesized that there would be significant improved due to varied intensities of plyometric training, namely, low, medium and high intensity plyometric training on selected motor fitness variables Explosive Strength compared to control group.
- It was hypothesized that there would be significant improvement due to varied intensities of Plyometric training, namely, low, medium and high intensity plyometric exercises, on selected physiological variables, resting heart rate among volleyball players compared to control group.
- It was hypothesized that there would not be any significant differences among different intensities of plyometric training on selected motor fitness variables of college women volleyball players.
- It was hypothesized that there would not be any significant differences among different intensities of plyometric training on selected physiological variables of college women volleyball players.

Limitations
The research study was limited to the following factors, and these limitations would be taken in to consideration while analyzing the data and interpreting the results.

- While conducting the study the external factors like atmosphere conditions, cultural influence, and socio-economic condition and also the body structure of the subjects were not taken in to consideration.
- No attempt was made to control the subjects participating in other extracurricular activities.
- Though the subjects were motivated verbally, no attempt was made to differentiate their motivation level during testing and training.
- The investigator did not consider the geographical location at the time of conducting the experiment.
- The exercises were classified in to low, medium and high intensity based the classification of experts.

Delimitations

The study delimited to the following aspect

- Only sixty women volleyball players from different colleges in Andhra Pradesh, who represented their college at intercollegiate level tournaments, were randomly selected as subjects for the study.
- This experimental study was administered to only four groups of fifteen (15) women volleyball players each.
- The age of the subjects ranged from 19-24 years only
- In the study, only low, medium and high intensities of plyometric training where considered as varied intensities of plyometric training.

Methodology

Selection of subjects

The purpose of the study was to find out the effects of varied intensity of Plyometric training on selected motor fitness and physiological variables among college women volleyball players. To achieve the purpose of this study, sixty women volleyball players were selected from different colleges of Andhra Pradesh who represented their colleges in intercollegiate level volleyball tournaments. The selected subjects were of age group ranging from 19 to 24 years with standard deviation of $\pm$ 2.1. The subjects were randomly divided into four groups and each group contained fifteen subjects. Group I acted as experimental group I and Group II acted as experimental group II group III acted as experimental group III and the fourth group was considered as control group.

Selection of variables

The investigator reviewed scientific journals, books and periodicals on different training methods especially plyometric exercises. Based on the experience gained and in consultation with the Guide the following dependent and independent variables were selected for this study.

Dependent Variables

Motor Fitness Variables

1. Explosive Strength

Physiological Variables

1. Resting Heart Rate

Independent Variables

1. 12 Weeks Low Intensity Plyometric Exercises
2. 12 Weeks Medium Intensity Plyometric Exercises
3. 12 Weeks High Intensity Plyometric Exercises

Experimental design

For the purpose of the study, random group design was employed. Randomly selected college women volleyball players, who represented their college (N=60) were divided into four groups consisting of 15 in each group. Experimental Group I underwent low intensity plyometric training, experimental group II underwent medium intensity plyometric training and experimental group III underwent high intensity plyometric training group four was control group which did not participated in any special training. The control group did not participate in any special exercises except of their routine. Pre test scores were obtained using standard tests on selected motor fitness and physiological variables, such as, Explosive Strength and Resting Heart Rate before the experimental period and the post test scores were obtained immediately after the twelve weeks experimental period. The difference between the pre test and post test means were subjected to statistical treatment using ANCOVA, which was the effect of varied intensities of plyometric training. In all cases 0.05 level was fixed to test the hypothesis of the study.

Statistical technique

To find out the effects of varied intensity plyometric training (low, medium and high intensities) on selected motor fitness and physiological variables of the subjects, the pre test and post test scores were analysed by suing ANCOVA technique. When the F ratio was found to be significant, Scheffe's post hoc test was applied to test which of the possible comparison among the means was significant differences among three groups, namely, experimental group I, experimental group II, experimental group III and control group in the development of twelve weeks of training. (Thirumalaisamy, 1989)

The test and retest correlation coefficient values on selected variables, tests conducted and the obtained 'r' are detailed in Table I

Table 1: Intra Class Correlation Coefficient of Test – Retest Scores

S.No	Variables	Tests	Obtained 'r'
1	Explosive Strength	Vertical Jump test	0.84*
2	Resting Heart Rate	Palpation method	0.88*

***** Significant at 0.01 level

Required table value (2,8) = 0.765

Results on explosive strength

The descriptive statistics comparing the initial and final means of Explosive Strength due to varied intensities (low, medium and high intensity) of plyometric training, and control groups of college men volleyball players is presented in Table II.

Table 2: Descriptive Statistics on Low, Medium and High Intensity Plyometric training and Control Groups on Explosive Strength

Groups	Test	Mean	Standard Deviation	RANGE	
				Min	Max
Low Intensity Plyometric training	Initial	41.73	6.05	35.00	56.00
	Final	46.20	5.52	41.00	58.00
	Adjusted Mean	49.07			
Medium Intensity Plyometric training	Initial	46.87	7.58	35.00	58.00
	Final	50.33	6.83	41.00	61.00
	Adjusted Mean	48.76			
High Intensity Plyometric training	Initial	45.80	7.91	35.00	58.00
	Final	50.67	7.92	40.00	64.00
	Adjusted Mean	50.02			
Control Group	Initial	45.80	7.91	35.00	58.00
	Final	47.27	7.34	35.00	59.00
	Adjusted Mean	46.62			

Table-II shows that the pre test mean on Explosive Strength of low intensity plyometric training group was 41.73 with standard deviation ± 6.05 pre test mean of medium intensity plyometric training group was 46.87 with standard deviation ± 7.58, the pre test mean of high intensity plyometric training group was 45.80 with standard deviation ± 7.91, the pre test mean of control group was 45.80 with standard deviation ± 7.91.

The descriptive statistics on post test mean on Explosive Strength of low intensity plyometric training group was 46.20 with standard deviation ± 5.52 post test mean of medium intensity plyometric training group was 50.33 with standard deviation ± 6.83, the post test mean of high intensity plyometric training group was 50.67 with standard deviation ± 6.83, the post test mean of control group was 47.27 with standard deviation ± 7.34.

The adjusted mean on Explosive Strength on low intensity plyometric training group was 49.07, medium intensity plyometric training group was 48.76, high intensity plyometric training group was 50.02 and control group was 46.62, as shown in Table II.

The obtained mean values on the experimental and control groups were presented in Figure I.

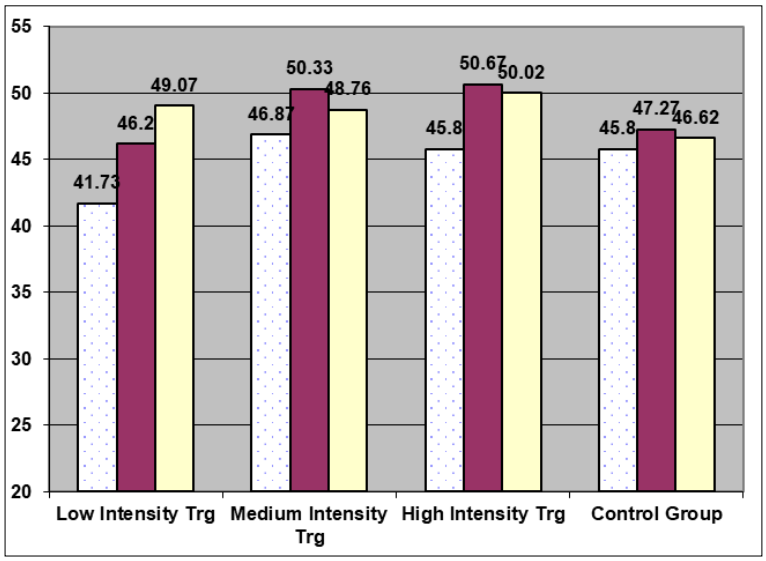

Fig 1: Bar diagram showing pre, post and adjusted means on explosive strength due to low, medium and high intensity plyometric training and control groups

The results on descriptive statistics proved that there exists differences in different intensities of plyometric training compared to control group of variable Explosive Strength. And to test statistical significance of the differences, the obtained data on Explosive Strength using ANCOVA was presented in Table III.

Table 3: Computation of analysis of covariance due to low, medium and high intensity plyometric training and control group on explosive strength

	Source of Variance	Sum of Squares	df	Mean Squares	Obtained F
Pre Test Mean	Between	231.38	3	77.13	
	Within	3069.47	56	54.81	1.41
Post Test Mean	Between	222.18	3	74.06	
	Within	2712.00	56	48.43	1.53
Adjusted Post Test Mean	Between	92.62	3	30.87	
	Within	409.85	55	7.45	4.14*

Required $F_{(0.05),(df\ 3,\ 56)} = 2.77$

* Significant at 0.05 level of confidence

As shown in Table III, the obtained F ratio of 1.41 on pre test means of the groups was not significant at 0.05 level as the obtained F value was less than the required table F value of 2.77 to be significant at 0.05 level. This shows that there was no significant difference in means of the groups at initial stage.

The results presented in Table III, the obtained F ratio of 1.53 on post test means of the groups was significant at 0.05 level as the obtained F value was lesser than the required table F value of 2.77 to be significant at 0.05 level. This shows that there was no significant difference in means of the groups at post test stage.

Taking into consideration of the pre test means and post test means, adjusted post test means were determined and analysis of covariance was done. The obtained F value on adjusted means was 4.14. The obtained F value was greater than the required value of 2.77 and hence it was accepted that there was significant differences among the adjusted means on the Explosive Strength of the subjects.

Since significant improvements were recorded, the results were subjected to post hoc analysis using Scheffe's Confidence Plyometric test. The results were presented in Table IV.

Table 4: Multiple Comparisons between Low, Medium, and High intensity plyometric training and Control Groups and Scheffe's Post Hoc Analysis on Explosive Strength

Low intensity plyometric training Group	Medium intensity plyometric training Group	High intensity plyometric training Group	Control Group	Mean diff	C.I
49.07	48.76			0.31	2.85
49.07		50.02		-0.94	2.85
49.07			46.62	2.46	2.85
	48.76	50.02		-1.26	2.85
	48.76		46.62	2.14	2.85
		50.02	46.62	3.40*	2.85

***** Significant at 0.05 level.

The post hoc analysis of obtained ordered adjusted means proved that to be significant at 0.05 level confidence the required confidence plyometric was 2.85. The following paired mean comparisons were greater than the required confidence plyometric and were significant at 0.05 level.

Results on resting pulse rate

The descriptive statistics comparing the initial and final means of Resting Pulse Rate due to varied intensities (low, medium and high intensity) of plyometric training, and control groups of college men volleyball players is presented in Table V.

Table 5: Descriptive Statistics on Low, Medium and High Intensity Plyometric training and Control Groups on Resting Pulse Rate

Groups	Test	Mean	Standard Deviation	Range	
				Min	Max
Low Intensity Plyometric training	Initial	71.33	2.99	67.00	79.00
	Final	69.27	2.99	66.00	77.00
	Adjusted Mean	68.00			
Medium Intensity Plyometric training	Initial	70.07	2.81	66.00	77.00
	Final	67.13	2.90	63.00	74.00
	Adjusted Mean	67.13			
High Intensity Plyometric training	Initial	68.87	2.75	65.00	76.00
	Final	66.93	2.74	62.00	73.00
	Adjusted Mean	68.13			
Control Group	Initial	70.00	2.45	65.00	76.00
	Final	70.20	2.62	65.00	77.00
	Adjusted Mean	70.27			

Table V shows that the pre test mean on Resting Pulse Rate of low intensity plyometric training group was 71.33 with standard deviation $\pm$ 2.99 pre test mean of medium intensity plyometric training group was 70.07 with standard deviation $\pm$ 2.81, the pre test mean of high intensity plyometric training group was 68.87 with standard deviation $\pm$ 2.75, the pre test mean of control group was 70.00 with standard deviation $\pm$ 2.45.

The descriptive statistics on post test mean on Resting Pulse Rate of low intensity plyometric training group was 69.27 with standard deviation $\pm$ 2.99 post test mean of medium intensity plyometric training group was 67.13 with standard deviation $\pm$ 2.90, the post test mean of high intensity plyometric training group was 66.93 with standard deviation $\pm$ 2.90, the post test mean of control group was 70.20 with standard deviation $\pm$ 2.62.

The adjusted mean on Resting Pulse Rate on low intensity plyometric training group was 68.00, medium intensity plyometric training group was 67.13, high intensity plyometric training group was 68.13 and control group was 70.27, as shown in Table V.

The obtained mean values on the experimental and control groups were presented in Figure II.

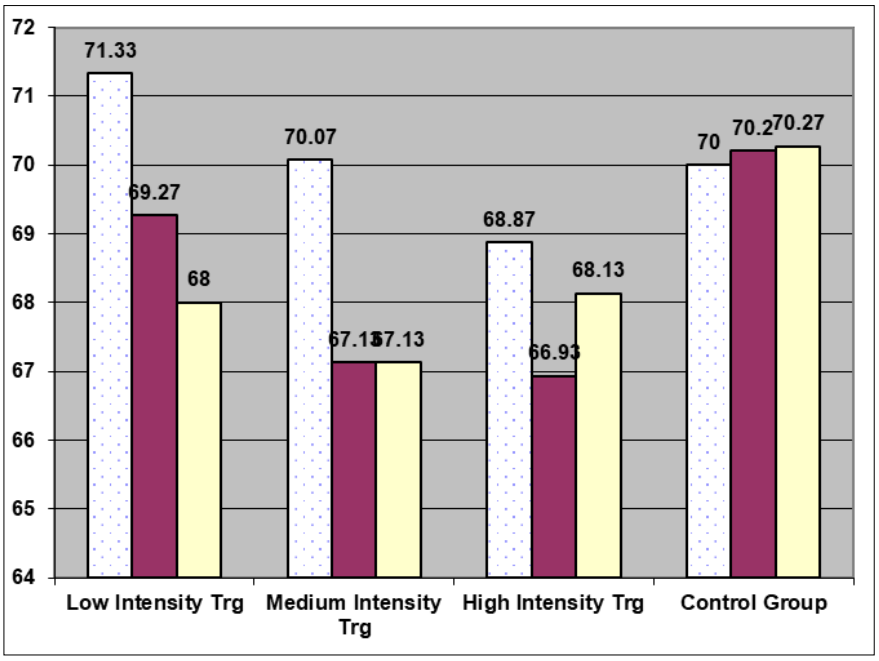

Fig 2: Bar diagram showing pre, post and adjusted means on resting pulse rate due to low, medium and high intensity plyometric training and control groups

The results on descriptive statistics proved that there exist differences in different intensities of plyometric training compared to control group of variable Resting Pulse Rate. And to test statistical significance of the differences, the obtained data on Resting Pulse Rate using ANCOVA was presented in Table VI.

Table 6: Computation of analysis of covariance due to low, medium and high intensity plyometric training and control group on resting pulse rate

	Source of Variance	Sum of Squares	Df	Mean Squares	Obtained F
Pre Test Mean	Between	45.73	3	15.24	2.00
	Within	426.00	56	7.61	
Post Test Mean	Between	116.18	3	38.73	4.88*
	Within	444.00	56	7.93	
Adjusted Post Test Mean	Between	79.71	3	26.57	68.95*
	Within	21.19	55	0.39	

Required $F_{(0.05), (df\ 3, 56)} = 2.77$

* Significant at 0.05 level of confidence

As shown in Table VII, the obtained F ratio of 2.00 on pre test means of the groups was not significant at 0.05 level as the obtained F value was less than the required table F value of 2.77 to be significant at 0.05 level. This shows that there was no significant difference in means of the groups at initial stage.

The results presented in Table VII, the obtained F ratio of 4.88 on post test means of the groups was significant at 0.05 level as the obtained F value was greater than the required table F value of 2.77 to be significant at 0.05 level. This shows that there was significant difference in means of the groups at post test stage.

Taking into consideration of the pre test means and post test means, adjusted post test means were determined and analysis of covariance was done. The obtained F value on adjusted means was 68.95. The obtained F value was greater than the required value of 2.77 and hence it was accepted that there was significant differences among the adjusted means on the Resting Pulse Rate of the subjects.

Since significant improvements were recorded, the results were subjected to post hoc analysis using Scheffe's Confidence Plyometric test. The results were presented in Table VII.

Table 7: Multiple Comparisons between Low, Medium, and High intensity plyometric training and Control Groups and Scheffe's Post Hoc Analysis on Resting Pulse Rate

Low intensity plyometric training Group	Medium intensity plyometric training Group	High intensity plyometric training Group	Control Group	Mean diff	C.I
68.00	67.13			0.87*	0.65
68.00		68.13		-0.12	0.65
68.00			70.27	-2.26*	0.65
	67.13	68.13		-1.00*	0.65
	67.13		70.27	-3.13*	0.65
		68.13	70.27	-2.14*	0.65

***** Significant at 0.05 level.

The post hoc analysis of obtained ordered adjusted means proved that to be significant at 0.05 level confidence the required confidence plyometric was 0.65. The following paired mean comparisons were greater than the required confidence plyometric and were significant at 0.05 level.

Low intensity plyometric training Vs Medium intensity plyometric training Groups (MD: 0.87)

Low intensity plyometric training Vs Control Groups (MD: -2.26)

Medium intensity plyometric training Vs High intensity plyometric training Group (MD: -1.00)

Medium intensity plyometric training Vs Control Groups (MD: -3.13)

High intensity plyometric training Vs Control Groups (MD: -2.14)

The following paired mean comparisons were less than the required confidence plyometric and were not significant at 0.05 level.

Low intensity plyometric training Vs High intensity plyometric training Groups (MD: -0.12.

Findings

Based on the results it was found that varied intensities of plyometric training, namely, low, medium and high intensity plyometric training can significantly alter selected motor fitness variables, Explosive Strength and physiological variables, Resting Pulse Rate compared to control group.

Conclusions

Within the limitations and delimitations of the study, the following conclusions were drawn.

1. It was concluded that twelve weeks varied intensities of plyometric training significantly improved motor fitness variable, explosive power among college men volleyball players compared to control group. Comparison among the experimental groups proved that there were no significant differences on explosive power among college men volleyball players.
2. It was concluded that twelve weeks varied intensities of plyometric training significantly altered physiological variable, resting pulse rate among college men volleyball players compared to control group. Comparison among the experimental groups proved that there were significant differences between medium and high intensity plyometric groups and medium and low intensity plyometric groups on resting pulse rate among college men volleyball players.
3. It was concluded that twelve weeks varied intensities of plyometric training significantly altered physiological variable, cardiovascular endurance among college women volleyball players compared to control group. Comparison among the experimental groups proved that there were no significant differences among experimental groups on cardiovascular endurance of college women volleyball players.

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