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Research article

IMPACT OF RESISTANCE TRAINING FOLLOWED BY SPRINT TRAINING AND RESISTANCE TRAINING FOLLOWED BY PLYOMETRIC TRAINING ON POWER PARAMETERS

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Abstract

This study was designed to determine impact of resistance training followed by sprint training and resistance training followed by plyometric training on power parameters of men basketball players. 90 male basketball players were selected from various colleges affiliated by Bharathiar University in Coimbatore district of Tamil Nadu. The selected subjects were divided into three equal groups consisting of thirty each. No attempt was made to equate the groups. Experimental group I (n = 30) underwent resistance training followed by sprint training, experimental group II (n = 30) underwent resistance training followed by plyometri training for a period of 12 weeks and group III (n = 30) acted as control group. The standard test was used to measure the power variables like vertical jump height, maximum power, elastic leg power. The collected data have been processed by using 't' ration, analysis of covariance (ANCOVA) and scheffe's post hoc test. The result reveal that both training produced significant changes in the power parameters and Resistance training followed by plyometric training was found to be better than resistance training followed by sprint training to produce significant changes in power parameters vertical jump height, maximum power and elastic leg power right and left leg of basketball players.

Keywords: *Resistance, Sprint, Plyometric, Vertical Jump, Maximum Power, Elastic leg power*

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INTRODUCTION

As all basketball players know, power is a vital ingredient in the game and coaches constantly search for ways to improve power, most specifically the ability to jump higher and run faster. Surprisingly, there is tremendous controversy on the most effective way to achieve power. Power movements are ballistic in nature (performed at a high velocity) and rely heavily on the involvement of momentum. Examples include the power clean (and its closest derivatives), medicine ball training and various 'plyometrics' exercises. These movements are performed in the belief that the power exhibited during training will directly transfer to enhance the specific sports skill. (**Stein, 2005)**

A sprinter would probably benefit more from forefoot landing jumps, as the sprint action is performed from a similar foot-strike position, whereas a basketball or volleyball player is likely to develop greater vertical spring a key requirement of the game by using flat footed landings. Muscle firing patterns are very specific, and conditioning skills must mirror sports skill for optimum results **(Goyal, 2008).**

The NSCA reports strength gains of approximately 30% are typically observed after appropriately designed and supervised short-term resistance training programs undertaken by children and adolescents. Resistance training may also benefit sports performance. Explosive muscular power and rate of force production are the basis for most sporting actions. Speed and power are essential characteristics needed for successful performance in a large range of sports. It has been the increase in the muscular strength and power levels of adolescents after participation in resistance training may improve sporting performance, but there is little direct evidence to conclude that increases in muscular strength and power alone will improve adolescent sporting performance **(Pediatrics, 2008).**

METHODOLOGY

To fulfill the purpose of the study ninety basketball players were randomly selected from Sri Krishna College of arts and science, Bishop Appasamy College of arts and science, Dr.GRD College of science and Bharathiar University departments in Coimbatore district of Tamil Nadu. The selected subjects were divided into three equal groups consisting of thirty each. No attempt was made to equate the groups. Experimental group I (n = 30) underwent resistance training followed by sprint training, experimental group II (n = 30) underwent resistance training followed by plyometric training for a period of 12 weeks and group III (n = 30) acted as control group (CG), the subjects in control group were not engaged in any training programme other than their regular work. The power parameters assessed by reliable test, the vertical jump height was measured by Sargent jump, maximum power was assessed by 1RM squat test and elastic leg power was measured by 25 m hop test. The pre-test and post-test data were collected before and after the training programme for a period of 12 weeks.

TRAINING PROTOCOLS

The subjects were trained 3 days per week and the training programme for each session lasted for 55-60 minutes approximately, each training session was divided into two parts the first 20 minutes for resistance training and 10 minutes rest then 20 minutes for sprint training for experimental group I. The experimental group II underwent first 20 minutes resistance training and 10 minutes rest then 20 minutes plyometrics training for each session which included 5 minutes warming up and 5 minutes relaxation procedure after training programme for three days per week for a period of 12 weeks. The training sessions were held between 6.00 pm to 7.30 pm. The length of the training intervention for this study was based on the fact that twelve weeks has been shown to be sufficient to provide significant changes in college men students **(Rice** *et al.*, **1999).**

STATISTICAL TECHNIQUE

The pre-test and post-test data of the experimental and control groups on the respective variables were analyzed with various statistical techniques. Descriptive statistics such as mean and standard deviation were found in order to get the basic idea of the data distribution. ‘t’ test was computed for finding whether there is any statistically significant pre-test to post-test mean differences in their respective variables of each groups. By using the analysis of variance (ANOVA) for testing the significance of the difference among the post-test means of the experimental and control groups. ANCOVA tests the significance of ‘adjusted post-test mean’ differences between the experimental and control groups for each variable and Scheffee’s post hoc test was applied to test the significant difference between the paired adjusted means.0.05 level of confidence was fixed for power parameters to test the level of significance.

ANALYSIS AND RESULTS OF THE STUDY

Vertical Jump Height

TABLE - I
COMPUTATION OF ‘t’ RATIO ON VERTICAL JUMP HEIGHT

Groups	Pre – test mean	Pre – test S. D (±)	Post - test mean	Post – test S. D (±)	‘t’ ratio
Sprinting after resistance training group(SARTG)	46.43	3.99	51.57	5.48	5.77*
Plyometrics after resistance training group (PARTG)	46.60	4.62	55.70	4.65	12.45*
Control group(CG)	46.83	4.33	48.06	4.93	1.82

*Significant at 0.05 level for the degrees of freedom (1 and 29), 2.045

The't' ratio on vertical jump height of RTFST and RTFPT were 5.77 and 12.45 respectively. Since, these values were higher than the required table value of 2.045, it was found to be statistically significant at 0.05 level of confidence for degrees of freedom 1 and 29. Further, the obtained 't' ratio between pre and post-test of the control group 1.82 was lesser than the required table value of 2.045, and it was found to be not statistically significant. From the results it was inferred that, combinations of RTFST and RTFPT produced significant improvement on vertical jump height of basketball players.

TABLE - II
ANALYSIS OF COVARIANCE ON PRE POST AND ADJUSTED POST TEST MEANS ON VERTICAL JUMP HEIGHT

Test	Sprinting after resistance training group (SARTG)	Plyometrics after resistance training group (PARTG)	Control group (CG)	Source of varian ce	df	Sum of squares	Mean square	F-ratio
Pre-test mean	46.43	46.60	46.83	B .G	2	2.42	1.21	0.07
				W .G	87	1624.73	18.68	
Post-test mean	51.57	55.70	48.06	B .G	2	876.02	438.01	17.29*
				W .G	87	22.03.53	25.33	
Adjusted post-test mean	51.70	55.71	47.92	B .G	2	911.69	455.85	27.88*
				W .G	86	1405.94	16.34	

*Significant at 0.05 level for the degrees of freedom (2, 87) and (2, 86), 3.10

The obtained 'F' ratio for the pre-test means of RTFST and RTFPT and CG on vertical jump height was 0.07. Since, the 'F' value was less than the required table value of 3.10 for the degrees of freedom 2 and 87, it was found to be not significant at 0.05 level of confidence. Further, the 'F' ratio for post-test means of RTFST and RTFPT and CG on vertical jump height was 17.29. Since, the ‘F’ value was higher than the required table value of 3.10 for the degrees of freedom 2 and 87, it was found to be statistically significant at 0.05 level of confidence. The obtained ‘F’ ratio for the adjusted post-test means of RTFST and RTFPT and CG on jump height was 27.88. Since, the ‘F’ value was higher than the required table value of 3.10 for the degrees of freedom 2 and 86, it was found to be statistically significant at 0.05 level of confidence. The results revealed that there was a significant difference in post-test means among RTFST and RTFPT and CG on vertical jump height of basketball players.

The mean difference between RTFST and RTFPT, RTFST and CG, RTFPT and CG were 4.01, 3.78 and 7.79 respectively. From these results it was inferred that RTFPT produced significant improvement in vertical jump height of basketball players than RTFST training and CG groups.

Maximum Power

TABLE - III
COMPUTATION OF ‘t’ RATIO ON MAXIMUM POWER

Groups	Pre – test mean	Pre – test S. D (±)	Post - test mean	Post – test S. D (±)	‘t’ ratio
Sprinting after resistance training group(SARTG)	90.85	11.58	115.75	17.44	7.41*
Plyometrics after resistance training group (PARTG)	91.33	10.30	122.17	14.59	12.58*
Control group(CG)	90.37	10.15	92.37	11.48	1.90

*Significant at 0.05 level for the degrees of freedom (1 and 29), 2.045

The ‘t’ ratio on maximum power of RTFST and RTFPT were 7.41 and 12.58 respectively. Since, these values were higher than the required table value of 2.045, it was found to be statistically significant at 0.05 level of confidence for degrees of freedom 1 and 29. Further, the obtained ‘t’ ratio between pre and post-test of the control group 1.90 was lesser than the required table value of 2.045, and it was found to be not statistically significant. From the results it was inferred that, RTFST and RTFPT produced significant improvement in the maximum power of basketball players.

TABLE - IV
ANALYSIS OF COVARIANCE ON PRE, POST AND ADJUSTED POST TEST MEANS ON MAXIMUM POWER

Test	Sprinting after resistance training group (SARTG)	Plyometrics after resistance training group (PARTG)	Control group (CG)	Source of variance	df	Sum of squares	Mean square	F-ratio
Pre-test mean	90.85	91.33	90.37	B .G	2	14.02	7.00	0.06
				W .G	87	9952.20	114.39	
Post-test mean	115.75	122.17	92.37	B .G	2	14759.94	7379.97	34.12
				W .G	87	18816.50	216.28	
Adjusted post-test mean	115.8	121.9	92.67	B .G	2	14194.16	7097.08	41.43
				W .G	86	14733.02	171.31	

*Significant at 0.05 level for the degrees of freedom (2, 87) and (2, 86), 3.10

The obtained ‘F’ ratio for the pre-test means of RTFST, RTFPT and CG on maximum power was 0.06. Since, the ‘F’ value was less than the required table value of 3.10 for the degrees of freedom 2 and 87, it was found to be not significant at 0.05 level of confidence. Further, the ‘F’ ratio for post-test means of RTFST, RTFPT and CG on maximum power was 34.12. Since, the ‘F’ value was higher than the required table value of 3.10 for the degrees of freedom 2 and 87, it was found to be statistically significant at 0.05 level of confidence. The obtained ‘F’ ratio for the adjusted post-test means of RTFST, RTFPT and CG on maximum power was 41.43. Since, the ‘F’ value was higher than the required table value of 3.10 for the degrees of freedom 2 and 86, it was found to be statistically significant at 0.05 level of confidence. The results revealed that there was a significant difference in post-test means among RTFST, RTFPT and CG on maximum power of basketball players.

The mean difference between RTFST and CG, RTFPT and CG were 23.13 and 29.23 respectively. From these results it was inferred that twelve weeks of RTFPT produced significant improvement in maximum power of basketball players than RTFST training and CG groups.

Elastic leg power

TABLE - V
COMPUTATION OF 't' RATIO ON ELASTIC LEG POWER

Groups	Pre – test mean	Pre – test S. D (±)	Post - test mean	Post – test S. D (±)	't' ratio
Sprinting after resistance training group(SARTG)	7.12	0.84	6.52	0.61	5.57*
Plyometrics after resistance training group (PARTG)	7.09	0.61	6.11	0.39	8.15*
Control group(CG)	7.08	0.66	7.11	0.71	0.11

*Significant at 0.05 level for the degrees of freedom (1 and 29), 2.045

The 't' ratio on elastic leg power of RTFST and RTFPT were 5.57 and 8.15 respectively. Since, these values were higher than the required table value of 2.045, it was found to be statistically significant at 0.05 level of confidence for degrees of freedom 1 and 29. Further, the obtained 't' ratio between pre and post-test of the control group 0.11 was lesser than the required table value of 2.045, and it was found to be not statistically significant. From the results it was inferred that, RTFST and RTFPT produced significant improvement in the elastic leg power of basketball players.

TABLE - VI
ANALYSIS OF COVARIANCE ON PRE, POST AND ADJUSTED POST TEST MEANS ON ELASTIC LEG POWER

Test	Sprinting after resistance training group (SARTG)	Plyometrics after resistance training group (PARTG)	Control group (CG)	Source of variance	df	Sum of squares	Mean square	F-ratio
Pre-test mean	7.12	7.09	7.08	B .G	2	0.014	0.007	0.013
				W .G	87	44.43	0.51	
Post-test mean	6.51	6.11	7.11	B .G	2	15.11	7.56	21.85*
				W .G	87	30.09	0.35	
Adjusted post-test mean	6.51	6.11	7.12	B .G	2	15.15	7.58	24.46*
				W .G	86	26.64	0.31	

*Significant at 0.05 level for the degrees of freedom (2, 87) and (2, 86), 3.10

The obtained 'F' ratio for the pre-test means of RTFST, RTFPT and CG on elastic leg power was 0.013. Since, the 'F' value was less than the required table value of 3.10 for the degrees of freedom 2 and 87, it was found to be not significant at 0.05 level of confidence. Further, the 'F' ratio for post-test means of RTFST, RTFPT and CG on elastic leg power was 21.85. Since, the 'F' value was higher than the required table value of 3.10 for the degrees of freedom 2 and 87, it was found to be statistically significant at 0.05 level of confidence. The obtained 'F' ratio for the adjusted post-test means of RTFST, RTFPT and CG on elastic leg power right leg was 24.46. Since, the 'F' value was higher than the required table value of 3.10 for the degrees of freedom 2 and 86, it was found to be statistically significant at 0.05 level of confidence. The results revealed that there was a significant difference in post-test means among RTFST, RTFPT and CG on elastic leg power of basketball players.

The mean difference between RTFST and CG, RTFPT and CG were 0.60 and 1 respectively. From these results it was inferred that twelve weeks of RTFPT produced significant improvement in elastic leg power of basketball players than RTFST training and CG groups.

DISCUSSION ON FINDINGS

Inspection of the data in this study demonstrates that there are clear technical differences between resistance training followed by sprint training and resistance training followed by plyometric training on power parameters of improved vertical jump height, , maximum power, elastic leg power. The results show that the resistance training followed plyometric training group produced significant improvement over vertical jump height, maximum power, and reduction in time in elastic leg power than resistance training followed by sprint training group.

The factor to be noted in the present study is that, there is increase in vertical jump height, maximum power, and reduction in time in elastic leg power resistance training followed plyometric training than resistance training followed by sprint training. So, the resistance training followed plyometric training holds good to desired effect on power parameters.

From the results of the study it is speculated that training with resistance training followed plyometric training group is more efficient to bring out desirable changes over power parameters of basketball players.

The result of present study supports the report of **Eduardo and Manuel (2008)** combined practice of weight training and plyometrics significantly improved squat jump (SJ), countermovement jump (CMJ), Abalakov test (ABA), depth jump (DJ), mechanical power (MP), and medicine ball throw (MBT) and complex training is a useful working tool for coaches, innovative in this strength-training domain, equally contributing to a better time-efficient training.

The combined resistance and running-speed program provides better results than the conventional resistance training, regarding the power performance of soccer players **(Kotzamanidis** *et al.*, **2005)**. Acute plyometric exercise with weight exercise induce a substantial decline in jumping performance **(Beneka** *et al.,* **2012)**. Combined strength and power training significantly improved vertical jump height, ball-shooting speed, 10 m and 30 m sprint times, Yo-Yo intermittent endurance run (YYIER), and reduced sub maximal running cost (RC) **Wong** *et al.,* **(2010)**. Combined training approach using full-squat, parallel-squat, loaded countermovement jumping and plyometric training results in a light improvement in maximal strength, velocity of displacement and sprint performance and the resemblance between movement patterns and the velocity of displacement common to the training and testing methods also contributes to greater performance improvement **Saez** *et al.,* **(2012)**.

The positive influence of sprinting after resistance and plyometrics after resistance on acceleration speed, maximum speed, multiple speed, stride length and speed endurance is registered. The value of acceleration speed, maximum speed, multiple speed, and stride length and speed endurance were increased in the final measuring.

In this study the training program was designed to improve the power parameters focusing on vertical jump height, maximum power, and elastic leg power. A complex training methodology combining resistance followed by sprint training and resistance followed by plyometrics training, which enabled the investigator to supervise the combination of training in a single workout on the same day, Furthermore, an articulation of both these modalities is an efficient way to produce gains in speed and power parameters **(Human Kinetics, 1995),** which is supported by results of the present study.

One possible explanation for enhanced values on selected variables lies in the fact that complex training stimulates the neuromuscular system **(Chu, 1998)** that is, it activates both muscular fibers and nervous system, so that slow twitch fibers behave like fast twitch fibers. Further resistance training increased motor neuron excitability and reflex potentiation, which may lead to better training conditions for subsequent plyometrics exercises this fact may have contributed to the increments in the present study.

CONCLUSIONS

Within the limitations and on the basis of the findings, it was very clear that twelve weeks of resistance training followed by sprint training and resistance training followed by plyometric training produced significant changes in the power parameters of vertical jump height, maximum power and elastic leg power of basketball players.

Resistance training Followed by plyometric training was found to be better than resistance training followed by sprint training to produce significant changes in power parameters vertical jump height, maximum power and elastic leg power of basketball players.

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