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Modification of Leg Strength Explosive Power and Flexibility after Resistance Training Followed by Yoga Practices and Combination of Resistance and Plyometric Training Followed by Yoga Practices

Dr. S. Chidambara Raja[1]*, Dr. P. Balaji[2]

[1]Principal, St. John's College of Physical Education, Veeravanallur, Tirunelveli
[2]Associate Professor, Department of Physical Medicine & Rehabilitation, Cuddalore District Medical College & Hospital, Chidambaram

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***Corresponding author:** Dr. S. Chidambara Raja
Principal, St. John's College of Physical Education, Veeravanallur, Tirunelveli

Abstract

The purpose of the present study was to find the alteration in leg strength, explosive power and flexibility after resistance training followed by yoga practice and combination of resistance and plyometric training followed by yoga practices. For this purpose, forty-five male players of various games and sports from St. John's College of Physical Education, Veeravanallur, Tirunelveli District, Tamilnadu, India in the age group of 17 – 25 years were selected. They were divided into three equal groups (n = 15), each group consisted of fifteen subjects, in which group – I underwent resistance training followed by yoga practice, group – II underwent combination of resistance training and plyometric training followed by yoga practice and group – III acted as control group who did not participate in any special training apart from their regular curricula. The training period for this study was three days in a week for twelve weeks. Prior to and after the training period the subjects were tested for leg strength, explosive power and flexibility. Leg strength was assessed by using leg lift with dynamometer, explosive power was measured by administering standing broad jump and flexibility was assessed by administering sit and reach test. The analysis of covariance (ANCOVA) was used to find out the significant difference if any, among the experimental groups and control group on selected criterion variables separately. Since there were three groups involved in this study the Scheffė *S* test was used as pos-hoc test. It was concluded from the result of the study that the resistance training followed by yoga practice group and combination of resistance training and plyometric training followed by yoga practice group has positively altered the criterion variables, such as, leg strength, explosive power and flexibility. The result of the study also shown that there was no significant difference occurred between the experimental groups on selected criterion variables except explosive power. In explosive power, the combination of resistance training and plyometric training followed by yoga practice group has significantly improved than resistance training followed by yoga practice group and control group.

Keywords: resistance training, plyometric training, yoga practice, combined training, leg strength, explosive power and flexibility.

INTRODUCTION

Resistance to muscular contraction is used in resistance training, also known as strength training or weight training, to increase skeletal muscle growth, strength, and anaerobic endurance. The foundation of resistance training is the idea that, when necessary, the body's muscles will exert themselves to overcome a resisting force. The muscles get stronger when perform resistance training on a regular basis. Resistance training is a popular workout technique used to improve general population health and train athletes. Enhancing maximal muscular strength and functional performance through a methodical approach is the main goal of resistance training. The benefits of resistance training on neuromuscular adaptations in reaching maximal muscle strength have been the subject of several recent research, which have revealed the physiological mechanisms that improve muscle strength.

Resistance training offers a powerful stimulus to alter physical function and muscle performance. The World Health Organisation and the American College of Sports Medicine advise individuals who are obese to engage in strength-building activities at least twice a week (ACSM's Guidelines for Exercise Testing and

Prescription, (10th ed.), Wolters Kluwer, 2017). Higher and moderate loads had better results than lower loads in a supervised resistance training program for lower extremities. Additionally, it was shown that untrained people had greater muscle hypertrophy (Schoenfeld, *et al.,* 2016). A number of resistance training techniques, such as heavy loads (60–80% 1RM), many exercises, high training volume, and brief rest intervals (30–90s), have been devised to optimise the acute anabolic response (Crewther, *et al.,* 2008; Kraemer, 2009; Kraemer and Ratamess (2004); *McCaulley, et al., 2009).* It is well known that participation in a resistance training program can lead to exercise-induced increases in strength and power in children and adolescents (Faigenbaum *et al.,* 1996; Falk and Tenenbaum, 1996). Aghajani, Hojjati, Elmiyeh, (2014) found that the subjects' explosive power increased as a result of specific weight training in their research.

In a plyometric workout, a quick eccentric movement is followed by a quick concentric movement (Markovic, and Mikulic, 2010). The stretch-shortening cycle is the rapid change from the eccentric to the concentric phase of the action. In the last stage (i.e., the concentric action), the stretch-shortening cycle produces both increased propulsive forces and energy conservation (Turner, and Jeffreys, 2010). According to more recent findings, if age-appropriate training parameters are followed, plyometric exercise may also be safe and beneficial for kids and teenagers (Chu *et al.,* 2006; Marginson *et al.,* 2005). For instance, Kotzamanidis (2006) observed that plyometric exercise increased running velocity and jumping performance in prepubertal boys, and Matavulj *et al.,* (2001) discovered that plyometric training improved jumping performance in adolescent basketball players. Plyometric training, however, is not meant to be a stand-alone fitness regimen (Bompa, 2000; Chu *et al.,* 2006).

There is strong evidence that frequent engagement in a plyometric or resistance training program can enhance adult strength and power measurements (Chu, 2006; Fleck and Kraemer, 2004). Additionally, research indicates that when resistance and plyometric exercise are combined, there are more improvements in motor performance abilities than when each type of training is used alone (Adams *et al.,* 1992; Fatouros *et al.,* 1992; Polhemus *et al.,* 1981). Therefore, when adults want to improve their motor function, both resistance training and plyometric exercise are usually advised.

Plyometric exercises and weight training together improved vertical leaping performance (Adams, *et al.,* 1992; Bauer, Thayer, and Baras, 1990; Blakey, and Southard, 1987) or kept it same (Ford, *et al.,* 1983). This combination may offer a more potent training stimulus for vertical leaping performance than either weight training or plyometric training alone, according to Adams et al. (1992). When compared to plyometric training or resistance training alone, the combination of resistance training and plyometric training has grown in popularity as a training approach that produces greater outcomes for muscular power proxies (Adams, *et al.,* 1992; Fatouros, *et al.,* 2000). The force and velocity components of maximal power may be trained simultaneously when resistance and plyometric exercise are combined, according to Newton and Kraemer (1994). Furthermore, studies have indicated that, in comparison to a single training mode, a combination of resistance training and plyometrics is advantageous for maximal strength growth (Blakey, and Southard, 1987; De Villarreal, Requena, and Newton, 2010).

Additionally, Fleck and Kraemer's research (2004) indicates that when resistance and plyometric training are combined, there are more improvements in motor performance skills than when each type of training is used alone. In their study publications, Docherty *et al.,* (2004) and Chu (1998) said that the combined training strategy, which has been suggested to boost muscle power, mixes resistance training with plyometric training.

In addition to physical workouts, yoga poses are promoted at the gym. It can be done before or after an exercise regimen, depending on the intensity, kind, and amount of repetitions. In low to high intensity training regimes, several types of yoga positions are recommended for relaxation and cool down after a workout. Yoga positions have several health advantages, including pain relief (Barnes., Bloom., and Nahin, 2008; Lazaridou, *et al.,* 2019; Pasyar, *et al.,* 2019; Schmid, *et al.,* 2019; Chang, *et al.,* 2016), improved flexibility and balance (Polsgrove, Eggleston, and Lockyer, 2016), muscle strength (Gothe, and McAuley, 2016; Gupta and Aparna, 2020), skeletal muscle oxygen uptakes (Ha, *et al.,* 2015), and lung function (Budhi, Payghan, and Deepeshwar, 2019), among others.

Yoga is an activity that may improve several particular aspects of fitness at the same time. For example, after weeks of practice, joints that include movement in their kinetic chains may be optimised through better recruitment of muscle fibres, increased alignment, and expanded range of motion (*Arrico, 1997; Sivananda Yoga Vedanta Centre, 2010; McArdle, Katch, and Katch, 2014)*. Increased flexibility and decreased muscular tension lead to a stronger stretching impact on the surrounding connective tissue, which eventually "loosens" it and lessens the strain on the ligaments and joints (Coulter, 2010; *Sivananda Yoga Vedanta Centre, 2010).* As muscles grow more active, joints move more easily, and connective tissues become looser, more movement possibilities become feasible (Clark, and Ashland, 2012).

It's giving the body the best of both worlds when mix up the routines with yoga and weight training. The following are the main arguments in favour of combining these two effective techniques for greater strength and flexibility: Yoga helps stretch and lengthen the muscles that weight training develops. This combination provides you the flexibility and strength to effortlessly accomplish difficult positions (Singhdeo, 2025). Here, this research was conducted to find out any positive alterations after the respective training programme among male players of various disciplines.

METHODS

This study under investigation involves the experimentation of resistance training followed by yoga practice and combination of resistance training and plyometric training followed by yoga practices on leg strength, explosive power and flexibility. Only male players of various disciplines from St. John's College of Physical Education, Veeravanallur, Tirunelveli, in the age group of 17 – 23 years were selected. They were divided into three equal groups (n = 15), each group consisted of fifteen subjects, in which group – I underwent resistance training followed by yoga practice, group – II underwent combination of resistance training and plyoemtric training followed by yoga practice and group – III acted as control group who did not participate in any special training. The training programme was carried out for three days (Monday, Wednesday and Friday) per week during morning session only (6 am to 8 am) for twelve weeks. Leg strength was assessed by using leg lift dynamometer, explosive power was assessed by administering standing broad jump and flexibility was assessed by using sit and reach test.

Analysis of Data

The data collected prior to and after the experimental periods on leg strength, explosive power and flexibility of resistance training followed by yoga practice group, combination of resistance training and plyometric training followed by yoga practice group and control group were analysed and presented in the following tables.

Table – I present pre and post test means and the results of the paired sample t – test of resistance training followed by yoga practice group, combination of resistance training and plyometric training followed by yoga practice group and control group on selected dependent variables such as, leg strength, explosive paper, and flexibility.

Table – I: Paired sample 't'- test of yoga practice group and control group on selected dependent variables

Name of the Group	Name of the Dependent Variable	Pre-test Mean	Post-test Mean	t' - ratio
Resistance training followed by Yoga Practice Group	Leg Strength	55.38	58.56	21.59*
	Explosive power	1.46	1.57	24.31*
	Flexibility	5.16	5.49	32.87*
Plyometric training Resistance training followed by Yoga Practice Group	Leg Strength	56.01	59.72	29.63*
	Explosive power	1.49	1.67	43.55*
	Flexibility	5.20	5.56	55.19*
Control Group	Leg Strength	54.97	55.31	0.76
	Explosive power	1.48	1.49	0.003
	Flexibility	5.199	5.073	0.075

* Significant at 0.05 level of confidence. (Required table value for significance at 0.05 level of confidence with df 42 was 2.019)

Resistance training followed by Yoga Practice Group
Testing of Hypotheses – 1

The paired sample 't' was computed on selected dependent variables. The results were presented in the above Table – I. The 't' value for leg strength, explosive power and flexibility were 21.59, 24.31 and 32.87 respectively. All the 't' values are significantly higher than the required table value of 42 at 0.05 level of confidence was 2.019.

Researchers' hypothesis (H1)	There would be a significant improvement in the selected dependent variables due to yoga practice.	Accepted
Null hypothesis (H0)	There would be a significant improvement in the selected dependent variables due to yoga practice.	Rejected

Plyometric Training, Resistance training followed by Yoga Practice Group
Testing of Hypotheses – 2

The paired sample 't' was computed on selected dependent variables. The results were presented in the above Table – I. The 't' value for leg strength, explosive power and flexibility were 29.63, 43.55 and 55.19 respectively. All the 't' values are significantly higher than the required table value of 42 at 0.05 level of confidence was 2.019.

Researchers' hypothesis (H1)	There would be a significant improvement in the selected dependent variables due to yoga practice.	Accepted
Null hypothesis (H0)	There would be a significant improvement in the selected dependent variables due to yoga practice.	Rejected

Control Group

Testing of Hypotheses – 3

The paired sample 't' was computed on selected dependent variables. The results were presented in the above Table – I. The 't' value for leg strength, explosive power and flexibility were 0.76, 0.003 and 0.075 respectively. All the 't' values are significantly higher than the required table value of 42 at 0.05 level of confidence was 2.019.

Researchers' hypothesis (H1)	There would be a significant improvement in the selected dependent variables due to yoga practice.	Accepted
Null hypothesis (H0)	There would be a significant improvement in the selected dependent variables due to yoga practice.	Rejected

Based on the study's findings, the 12-week resistance training followed by yoga practice group, and combination of resistance training and plyometric training followed by yoga practice group improved performance in all specified dependent variables, including leg strength, explosive power and flexibility. Hence, researcher's hypothesis was accepted and the null hypothesis was rejected.

Table – II: Analysis of Covariance and 'F' ratio for Leg strength Explosive power and Flexibility for Resistance training followed by Yoga Practice Group, Combination of Resistance training and Plyometric Training followed by Yoga Practice Group and Control Group

Variable Name	Group Name Test ± S.D	Experimental Group – I	Experimental Group- II	Control Group	'F' Ratio
Leg strength (in Kg)	Pre-test Mean ± S.D	55.38 ± 2.26	56.01 ± 2.11	54.97 ± 1.86	0.97
	Post-test Mean ± S.D.	58.56 ± 2.14	59.72 ± 2.83	55.31 ± 2.09	44.88*
	Adj. Post-test Mean	59.117	61.561	55.082	83.22*
Explosive Power (in meter)	Pre-test Mean ± S.D	1.46 ± 0.08	1.49 ± 0.01	1.48 ± 0.07	1.08
	Post-test Mean ± S.D.	1.57 ± 0.36	1.67 ± 0.05	1.49 ± 0.07	39.33*
	Adj. Post-test Mean	1.552	1.693	1.476	102.55*
Flexibility (in inches)	Pre-test Mean ± S.D	5.16 ± 0.089	5.20 ± 0.066	5.199 ± 0.087	0.793
	Post-test Mean ± S.D.	5.49 ± 0.032	5.56 ± 0.086	5.073 ± 0.054	29.86*
	Adj. Post-test Mean	5.464	5.593	5.091	89.85

* Significant at .05 level of confidence. (The table value required for significant at .05 level with df 2 and 42 and 2 and 41 are 3.22 and 3.23 correspondingly).

Table – I displays the 'f' - ratio values of pre-test means of leg strength for resistance training followed by yoga practice group and combination of resistance, plyometric training followed by yoga practice group and control group was 0.97, which was less significant. The 'f' - ratio of post- and adjusted post-test means were 44.88 and 83.22 were superior to the requisite table value of 3.22 and 3.23 for significance with df 2 and 42 and 2 and 41 at .05 level of confidence. The result of this study showed that there was a significant dissimilarity among resistance training and yoga practice group and combination of resistance training, plyometric training and yoga practice group and control group on leg strength.

Table – I also indicate the 'f' - ratio values of pre-test means of explosive power for resistance training followed by yoga practice group and combination of resistance, plyometric training followed by yoga practice group and control group was 1.08, which was less significant. The 'f' - ratio of post- and adjusted post-test means were 39.33 and 102.55 were superior to the requisite table value of 3.22 and 3.23 for significance with df 2 and 42 and 2 and 41 at .05 level of confidence. The result of this study showed that there was a significant dissimilarity among resistance training and yoga practice group and combination of resistance training, plyometric training and yoga practice group and control group on explosive power.

The above table shows the 'f' - ratio values of pre-test mean of flexibility for resistance training and yoga practice group and combination of resistance training, plyometric training and yoga practice group and control group was 0.793, which was not significant at 0.05 level of confidence. The 'f' ratio of post and adjusted post-test means was 29.86 and 89.85 was superior to the requisite table value of 3.22 and 3.23 for significance with df 2 and 42 and 2 and 41 at .05 level of confidence. The result of this study showed that there was a significant dissimilarity among resistance training and yoga practice group and combination of resistance

training, plyometric training and yoga practice group and control group on flexibility.

Further to determine which of the paired means has a significant difference, Scheffĕ S test was applied as post-hoc test. The result of the follow-up test is presented in Table - II.

Table – III: Scheffĕ S Test for the Difference Between the Adjusted Post-Test Means of Leg strength, Explosive power and Flexibility

Adjusted Post-test Mean of Leg strength				
Experimental Group – I	**Experimental Group- II**	**Control Group**	**Mean Difference**	**CI**
59.117		55.082	4.035*	3.081
59.117	61.561		2.44	3.081
	61.561	55.082	6.509*	3.081
Adjusted Post-test Mean of Explosive power				
1.552		1.476	0.076*	0.0326
1.552	1.693		0.141*	0.0326
	1.693	1.476	0.44*	0.0326
Adjusted Post-test Mean of Flexibility				
5.464		5.091	0.373	0.286
5.464	5.593		0.129	0.286
	5.593	5.091	0.502	0.286

* Significant at 0.05 level of confidence.

RESULTS

After applying the analysis of covariance, the result of this study showed that there was a significant difference among resistance training followed by yoga practice group and combination of resistance training and plyometric training followed by yoga practice group and control group on the changes in leg strength, explosive power and flexibility after twelve weeks of training. The criterion variables such as, leg strength, explosive power and flexibility was improved for both the resistance training followed by yoga practice group and combination of resistance training and plyometric training followed by yoga practice group. There was a significant difference was found between the two experimental groups on explosive power in favor of resistance training and plyometric training followed by yoga practice group. Basically, the resistance training and yoga practice group and combination of resistance training, plyometric training and yoga practice group has tremendously improves the physical fitness variables.

CONCLUSIONS

When compared to the control group, the resistance training with yoga practise group, as well as the combination of resistance training, plyometric training, and yoga practise groups, showed a substantial gain in leg strength. Resistance training considerably enhanced leg strength among male football players, according to Rawte and Yadav, (2020). Blakeyl and Dan Southard (1987) found that a combination weight and plyometric training regimen improved leg strength considerably. Al Ameer's, (2020) compared the plyometric training programme, weight and plyometric training group enhanced leg strength, while resistance training alone group also improved leg strength.

The study's results showed that both training groups' explosive power considerably increased in terms of vertical distance. Kare (2019) found that the vertical leap greatly improved after plyometric training. According to Thakur, Mishra, and Rathore (2016) and Clutch, *et al.,* (1983), plyometric exercise and weight training significantly improved the vertical leap. Muthukumar and Sokkanathan, (2014) found that weight training and a combination of weight and plyometric training significantly improved vertical jump when compared to the control group.

The results of the study showed that both training groups' hip flexibility significantly improved. Strength training significantly increased hip flexibility, according to Takahashi, *et al.,* (2008) and Azeem and Ameer (2013). Ribeiroa, *et al.,* (2017) found that resistance training improved flexibility in young adult men and women, but that flexibility significantly decreased after the mid-training phase. According to Murugan, *et al.,* (2020), flexibility greatly increased following a brief time of plyometric coaching. Iftekher and Rahaman, (2017) discovered that after six weeks of yoga practice, shooters' hip flexibility significantly improved.

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