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Effect of plyometric training and combination of plyometric and strength training on leg strength and strength endurance

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Abstract
The purpose of the study was to find out the effect of plyometric training, and combination of plyometric and strength training on selected leg strength and strength endurance. Forty five male kabaddi players aged between 18 and 25 years were selected for the study. They were divided into three equal groups, each group consisting of fifteen subjects in which three experimental groups and one control group, in which the group I (n=15) underwent plyometric training, group II (n = 15) underwent combination of plyometric and strength training for three days (alternative days) per week for twelve weeks and group III, acted as control, which did not participate in any training. The subjects were tested on selected criterion variables such as leg strength and strength endurance at prior to and immediately after the training period. For testing the leg strength and strength endurance the dynamometer was used. The analysis of covariance (ANCOVA) was used to find out the significant difference if any, between the experimental groups and control group on selected criterion variables separately. Since there were three groups involved in the present study, the Scheffé's test was used as post-hoc test. The selected criterion variables such as leg strength and strength endurance were improved significantly for all the training groups when compared with the control group.

Keywords: Plyometric training, combination of plyometric and strength training, leg strength and strength endurance

Introduction
Physical training is focuses on mechanistic goals. The overall muscles and some specific skill will develop within particular period of time after the physical training. Physical fitness will be improved by the most of the physical training programme [1]. For ages, progress toward improved conditioning methods was sluggish, but in recent years, major advances have resulted in some incredible gains in performance [2]. A wider corpus of knowledge on athletes is now available, and this is reflected in training methods [3].
The idea of training and its techniques have evolved into a separate science, and fresh studies from other disciplines continue to add to this body of knowledge. The athlete serves as the focal point of training science and may provide coaches and sports scientists with a wealth of information [4]. Training is a methodical learning and acclimatisation process that entails repeating incremental labour [5].
The goal of physical training is to maximise an athlete's physiological capacity and best develop their biomotor skills [6]. Training is the process of creating an exercise routine that gets a sportsperson ready for a certain competition and increases their skill and energy levels. Originally, the intensity of sports training in any athletic event was represented by the athlete's ability to perform motor actions at varying degrees of strength, speed, resistance, and skill in order to achieve the individual and collective actions-the divisions of sports training method. [7]. During the preparation for a competition, decide which element to emphasise and achieve the desired performance goal [Zatsiorsky, (1995)].
Since decades, track and field athletes in Russia and Eastern Europe have been trained with plyometrics [9, 10, 11, 12, 13, 14]. Well-known Russian track and field coach Verkhoshanski (1973) [15] invented "shock training" or "jump training," as he dubbed it. Throwing, serving velocity, jump height and sprint speed are examples of sports performance outcomes that are frequently

quantified [16, 17, 18].

Resistance training is associated with an increase in bone mineral density and/or bone breadth in athletes when compared to a non-athletic control group [19, 20, 21]. Strength training may be an effective preventive measure since it is inversely connected to better bone health and a reduction in ageing [22].

According to studies [23, 24], plyometric activities are either less effective than weight training or more effective than other workouts in increasing vertical jumping ability. A combination of plyometric exercises and weight training enhanced or did not affect vertical jumping performance. Adams *et al*. (1992) [23] suggested that this combination may offer a more effective training stimulus for vertical jumping performance than either weight training or plyometric training alone. Loannis *et al*., (2000) [24] asserted that combining plyometric and weight training increased muscular strength, contrary to Clutch *et al*., (1983) [25], who did not reach the same conclusion.

The national field game of India features kabaddi heavily, and as more scientific methods are employed, it is becoming more and more well-liked. All participants get a great exercise at the same time, and no further equipment is needed [26].

Methods

In this study it was aimed to find out the effect of plyometric training, and combination of plyometric and strength training on leg strength and strength endurance. To achieve the purpose forty five male kabaddi players from who were enrolled at St. Peter's University in Chennai, Tamil Nadu for the academic year 2020–2021 were selected as subjects. They were divided into three equal groups of fifteen each and further divided as two experimental groups and one control group, in which the group I (n=15) underwent plyometric training (PT), group II (n = 15) underwent combination of plyometric and strength training (CPST) for three days (alternative days) per week for twelve weeks, and group III (n=15) acted as control which did not participate in any special training apart from the regular curricular activities.

For every training programme there would be a change in various structure and systems in human body. So, the researchers consulted with the experts and then selected the following variables as criterion variables:

1. Leg strength.
2. Strength endurance.

Analysis of the data

Analysis of covariance was used to determine the differences, if any, among the adjusted post-test means on selected criterion variables separately. Whenever the 'F' ratio for adjusted post-test mean was found to be significant, the Scheffé's test was applied as post-hoc test. The level of significance was fixed at .05 level of confidence to test the 'F' ratio obtained by analysis of covariance.

Table I: Analysis of Covariance and 'F' ratio for Leg Strength and Strength endurance of Plyometric training Group (PTG), Combination of plyometric and strength training Group (CPSTG) and Control Group (CG)

Variable Name	Group Name	PTG	CPSTG	CG	'F' Ratio
Leg Strength (in Kg.)	Pre-test Mean±S.D.	71.67±4.70	71.87±4.24	72.40±3.40	0.125
	Post-test Mean±S.D.	74.87±4.72	75.87±4.93	71.93±2.87	4.02*
	Adj. Post-test Mean	74.149	75.967	71.551	54.75*
Strength endurance (in Kg.)	Pre-test Mean±S.D.	28.93±1.87	29.53±2.53	29.27±1.53	0.332
	Post-test Mean±S.D.	31.47±1.64	32.20±3.03	29.27±1.22	7.85*
	Adj. Post-test Mean	31.756	31.931	29.246	36.28*

*Significant at .05 level of confidence. (The table value required for significance at .05 level of confidence with df 2 and 42 and 2 and 41 were 3.21 and 3.23 respectively).

Table-I shows that the leg strength pre-test "F" ratio value of 0.125 was less than the necessary table value of 3.21 for significant with df 2 and 42 at 0.05 level of confidence. For the post-test mean and adjusted post-test mean 'F' ratio value of 4.023 and 13.685 for the adjusted post-test scores was greater than the necessary table value of 3.24 for significant. According to Table-I, the pre-test averages of strength endurance "F" ratio value of 0.332 was less than the necessary table value of 3.21 for significant with df 2 and 42 at 0.05 level of confidence. For post-test and adjusted post-test mean "F" ratio values of strength endurance were 7.85 and 36.28 was greater than the necessary table value of 3.24 for significant.

Table II: Scheffẽ's Test for the Difference between the Adjusted Post-Test Mean of Leg Strength and Strength endurance

PTG	CPSTG	CG	Mean Difference	Confidence Interval at 0.05 level
Adjusted Post-test Mean for Leg Strength				
74.149		71.551	2.598*	1.14
74.149	75.967		1.818*	1.14
	75.967	71.551	4.416*	1.14
Adjusted Post-test Mean for Strength endurance				
31.756		29.246	2.51*	0.89
31.756	31.931		0.175	0.89
	31.931	29.246	2.685*	0.89

*Significant at 0.05 level of confidence.

Results

The adjusted post-test mean difference in leg strength between PTG and CG, PTG and CPSTG, and CPSTG and CG was 2.598, 1.818 and 4.416, respectively and these differences were significant at the.05 level of confidence, according to Table IV. Based on the study's findings, it can be said that PTG and CPSTG considerably boost leg strength. Additionally, the study's findings indicate that there was a substantial difference between the training groups in favour of CPSTG.

The adjusted post-test mean difference in strength endurance between PTG and CG, and CPSTG and CG was 2.51 and

2.685, respectively, and these differences were significant at the.05 level of confidence, according to Table-VI. But the difference between PTG and CPSTG was 0.175 which indicates an insignificant difference between the training groups. Based on the study's findings, it can be said that PTG and CPSTG considerably boost leg strength.

Conclusions

The research's findings revealed that PTG and CPSTG greatly boosted leg strength. According to Mohamed Abd El-Mawgoud Elsayed's (2012) [27] research, leg strength significantly increased following the PT programme. Additionally, Rahman Rahimi and Nasir Behpur (2005) [28] discovered that following the CPST regimen, leg strength significantly increased. Additionally, the outcome demonstrates that a substantial difference between the training groups was discovered in favour of CPSTG.

The study's findings also showed that after completing the PT and CPST regimen, strength endurance had significantly improved. After the PT, strength endurance significantly improved, according to Rahman Rahmi and Nasir Behpur (2005) [28]. Between the training groups, there was no discernible difference in terms of strength endurance.

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