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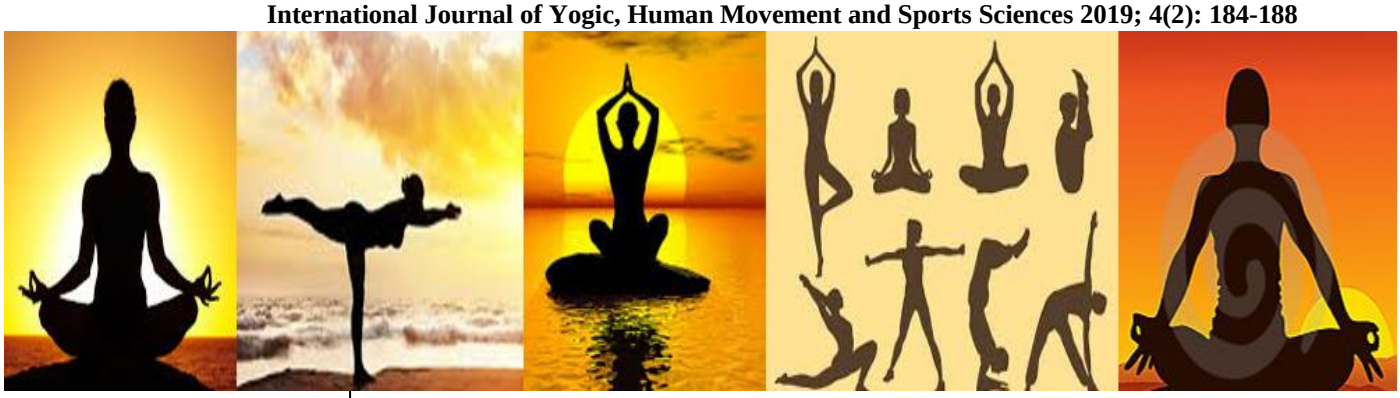

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Impact of resistance training and concurrent resistance and aerobic training on selected biomotor abilities football players

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Abstract
The intention of this study was to analyze the impact of resistance training and concurrent resistance and aerobic training on selected bio-motor abilities of football players. To achieve the purpose of this study, forty eight men football players were selected as subjects. The subjects were selected in the age group of 18 to 22 years and they were randomly assigned into three equal groups of 16 each. Experimental group-I performed resistance training, experimental group-II performed concurrent resistance and aerobic training and group-III was acted as control. The muscular strength and cardio respiratory endurance were selected as dependent variable. The research design of the study was random group design. The pre and post test data collected from the experimental and control groups on selected dependent variables were statistically analyzed by paired 't' test and Analysis of Covariance (ANCOVA). Since, three groups were involved, whenever the obtained 'F' ratio value in the adjusted post test mean was found to be significant, the Scheffe's test was applied as post hoc test. Further, percentage of changes was calculated to find out the improvement in selected dependent variables due to the impact of experimental treatment. It is concluded that due to the effect of resistance training and concurrent resistance and aerobic training the muscular strength and cardio respiratory endurance of the subjects were significantly improved. The result of the study produced 11.08% of improvement due to resistance training and 6.62% of improvement due to concurrent resistance and aerobic training.

Keywords: Concurrent resistance and aerobic training, muscular strength and cardio respiratory endurance, football players

Introduction
Today, football is a highly demanding game in which the participants are subjected to numerous actions that require overall strength and power production, speed, agility, balance, stability, flexibility, and the adequate level of endurance (Bloomfield, 2007; Gorostiaga *et al*., 2004; Helgerud *et al*., 2001; Krustrup *et al*., 2005) [2, 5, 6, 10], thus making the conditioning of players a complex process. The next step is to investigate methods that produce the integral effects that can be used in the conditioning of soccer players. But, we found that few studies have investigated the training methods that produce the integral effects on various abilities. Within the context of randomized intermittent, dynamic and skilled movement type sports, to which soccer undoubtedly belongs, the integrated effects are wanted. The problem is to decide which type of conditioning should be implemented to improve biomotor abilities of football players.

Athletes in predominately strength and endurance sports are frequently given training programs designed to induce positive changes in both endurance and strength attributes, particularly during the off-season. Strength and conditioning professionals prescribing aerobic exercise for their strength and endurance athletes often cite the benefit of enhanced recovery during the limited rest periods which intersperse the supramaximal work efforts. Recovery from anaerobic exercise is highly dependent upon aerobic metabolism. Thus, aerobic endurance training may help athletes recover more quickly between anaerobic work intervals, such as multiple sets in resistance training or repeated sprints. Strength and endurance athletes may perform endurance exercise in order to maintain an optimal body weight or to reduce body fat levels.

Working on strength and endurance at the same time, whether be in the same session, alternative days, alternative sessions, etc. Countless numbers of recreational workout enthusiasts complete their strength and endurance training workouts during the same training session, or within hours of one another. Many people, athletes and non-athletes, take part in a combination of resistance and aerobic training. These people are expecting to experience the benefits that these two different types of training have to offer. A number of studies have shown that performing these two types of training simultaneously can be detrimental to the gains that might be made in performing one type of training alone (Bell *et al*., 2000) [1].

Concurrent training can also yield benefits to those individuals who want to improve their endurance as athletes. The benefits aren't quite as drastic as those seen by untrained individuals, but if we have primarily focused on aerobic training, adding resistance training can yield some great benefits. Primarily, individuals would be able to put on some lean muscle mass and increase strength. And athletes are able to do this without much of a loss in endurance capacity and often an increase. The researcher is felt that there is a need to confirm the beneficial effects of resistance training and concurrent resistance and aerobic training on selected bio-motor abilities of football players. Moreover, very little research had been done in this area especially among football players, which motivated the investigator to take up the study.

Methodology

Subjects and Variables

To achieve the purpose of this study, forty eight men football players from Kanyakumari district, studying in various arts and science colleges affiliated to Manonmanium Sundaranar University, Tirunelveli district, Tamilnadu, India during the academic year 2017-2018 were selected as subjects. The subjects were selected in the age group of 18 to 22 years and they were randomly assigned into three equal groups of 16 each. Experimental group-I performed resistance training, experimental group-II performed concurrent resistance and aerobic training and group-III was acted as control. The muscular strength and cardio respiratory endurance was selected as dependent variables for the study and it was assessed by leg press and Cooper's 12 minutes run and walk tests.

Training Protocol

Training programme was administered to the football players for twelve weeks with three training units per week. The experimental group-I performed resistance training, group-II performed concurrent resistance and aerobic training. The resistance training program was a total body workout consisting of 3 sets of 6-10 repetitions on 8 exercises that trained all the major muscle groups. A percentage of each subject's one-repetition maximum for each exercise was used to determine the intensity of each week. The intensity and number of repetitions performed for each exercise was progressively increased. The aerobic training consists of continuous running with 65- 80% HRR. The running intensity was determined by a percentage of heart rate reserve (HRR). The intensity was increased as training progressed. Resistance training group performed only resistance exercises three days in a week for 12 weeks. Concurrent resistance and aerobic training group performed every odd numbered week resistance training in the morning session and aerobic training in the evening session. Every even numbered week they performed aerobic training in the morning session and resistance training in the evening session.

Collection of the Data

The data on the selected biomotor variables were collected prior to the commencement of experiment (pre test) and after twelve weeks of training period (post test). Both the pre and post tests were administered under identical conditions, with same apparatus, testing personal and testing procedures.

Statistical Technique

The data collected from the experimental and control groups on selected dependent variables were statistically analyzed by paired 't' test to find out the significant differences if any between the pre and post test. Further, percentage of changes was calculated to find out the chances in selected dependent variables due to the impact of experimental treatment. In order to nullify the initial mean differences the data collected from the three groups prior to and post experimentation on selected dependent variables were statistically analyzed to find out the significant difference if any, by applying the analysis of covariance (ANCOVA). Since, three groups were involved, whenever the obtained 'F' ratio value in the adjusted post test mean was found to be significant, the Scheffe's test was applied as post hoc test to determine the paired mean differences, if any. The level of confidence is fixed at 0.05 for significance.

Result

The descriptive analysis of the data on muscular strength and cardio respiratory endurance of experimental and control groups are presented in table-1.

Table 1: Descriptive Analysis of the Data on Muscular Strength and Cardio Respiratory Endurance of Experimental and Control Groups

Variable	Group	Test	Mean	SD	MD	't' ratio	Percentage of Changes
Muscular Strength	Resistance Training	Pre	63.81	6.19	7.07	15.64*	11.08%
		Post	70.88	6.26			
	Concurrent Training	Pre	62.19	5.32	4.12	13.11*	6.62%
		Post	66.31	4.83			
	Control Group	Pre	61.19	4.65	0.50	0.85	0.82%
		Post	60.69	3.40			
Cardio Respiratory Endurance	Resistance Training	Pre	2162.50	186.32	43.70	4.47*	2.02%
		Post	2206.20	162.64			
	Concurrent Training	Pre	2126.90	135.34	251.20	16.79*	11.81%
		Post	2378.10	114.79			
	Control Group	Pre	2046.90	190.78	23.80	0.99	1.16%
		Post	2023.10	146.41			

Table t-ratio at 0.05 level of confidence for 15 (df) =2.13
*Significant

The obtained 't' values on muscular strength of resistance training and concurrent training groups are 15.64 and 13.11 respectively which are greater than the required table value of 2.13 for significance at 0.05 level for 15 degrees of freedom. It revealed that due to the effect of resistance training and concurrent training the muscular strength of the football players were significantly improved. The result of the study produced 11.08% of improvement due to resistance training, 6.62% of improvement due to concurrent training on muscular strength.

The obtained 't' values on cardio respiratory endurance of resistance training and concurrent training groups are 4.47 and 16.79 respectively which are greater than the required table value of 2.13 for significance at 0.05 level for 15 degrees of freedom. It revealed that due to the effect of resistance training and concurrent training the cardio respiratory endurance of the football players were significantly improved. The result of the study produced 2.02% of improvement due to resistance training, 11.81% of improvement due to concurrent training on cardio respiratory endurance.

The pre and post test data collected from the experimental and control groups on muscular strength and cardio respiratory endurance was statistically analyzed by using Analysis of Covariance and the results are presented in table–2.

Table 2: Analysis of Covariance on Muscular Strength and Cardio Respiratory Endurance of Experimental and Control Groups

Variable	Resistance Training Group	Concurrent Training Group	Control Group	SoV	Sum of Squares	df	Mean squares	'F' ratio
Muscular Strength	69.66	66.49	61.73	B	490.30	2	245.15	82.40*
				W	130.91	44	2.98	
Cardio Respiratory Endurance	2168.0	2367.0	2073.0	B	705913.6	2	352956.82	112.62*
				W	137893.5	44	3133.94	

(The required table value for significance with degrees of freedom 2 & 44 is 3.21)
*Significant at .05 level of confidence

Table-2 shows that the adjusted post-test means on muscular strength of resistance training, concurrent training and control groups are 69.66, 66.49 and 61.73 respectively. The obtained 'F' value of 82.40 on muscular strength is greater than the required table value of 3.21 for df 2 and 44 at 0.05 level of confidence. Hence, it is concluded that significant differences exist between the adjusted post test means of resistance training, concurrent training and control groups on muscular strength.

Table-2 shows that the adjusted post-test means on cardio respiratory endurance of resistance training, concurrent training and control groups are 2168.00, 2367.00 and 2073.00 respectively. The obtained 'F' value of 112.62 on cardio respiratory endurance is greater than the required table value of 3.21 for df 2 and 44 at 0.05 level of confidence. Hence, it is concluded that significant differences exist between the adjusted post test means of resistance training, concurrent training and control groups on cardio respiratory endurance.

Since, the obtained 'F' value in the adjusted post test means was found to be significant, the Scheffe's test was applied as post hoc test to find out the paired mean difference, and it is presented in table-3.

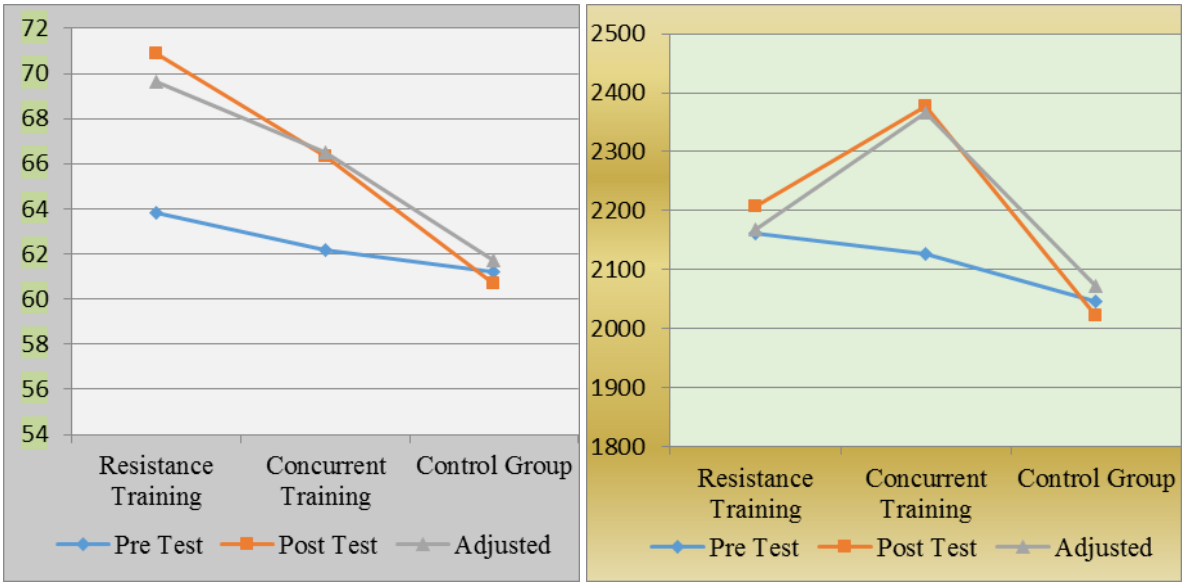
Table 3: Scheffe's Post Hoc Test for the Differences among Paired Means of Experimental and Control Groups on Muscular Strength and Cardio Respiratory Endurance

Variable	Resistance Training Group	Concurrent Training Group	Control Group	Mean Difference	Confidence Interval
Muscular Strength	69.66	66.49		3.17*	1.55
	69.66		61.73	7.93*	1.55
		66.49	61.73	4.76*	1.55
Cardio Respiratory Endurance	2168.00	2367.0		199.00*	50.15
	2168.00		2073.00	95.00*	50.15
		2367.00	2073.00	294.00*	50.15

*Significant at .05 level

The Scheffe's post hoc analysis proved that significant mean differences existed between resistance and concurrent training groups, resistance training and control groups, concurrent training and control groups on muscular strength since, the mean differences 3.17, 7.93 and 4.76 are higher than the confident interval value of 1.55 at 0.05 level of significance. Hence, it was concluded that due to the effect of resistance training and concurrent training the muscular strength of the subjects was significantly improved however, resistance training was significantly better than concurrent training in improving muscular strength.

The Scheffe's post hoc analysis proved that significant mean differences existed between resistance and concurrent training groups, resistance training and control groups, concurrent training and control groups on cardio respiratory endurance since, the mean differences 199.00, 95.00 and 294.00 are higher than the confident interval value of 50.15 at 0.05 level of significance. Hence, it was concluded that due to the effect of resistance training and concurrent training the cardio respiratory endurance of the subjects was significantly improved however, concurrent training was significantly better than resistance training in improving cardio respiratory endurance.



Muscular Strength Cardio Respiratory Endurance

Fig 1: Diagram Showing the Mean Values on Muscular Strength and Cardio Respiratory Endurance of Experimental and Control Groups

Discussion

It is well known that strength training increases muscle mass and strength. These findings agree with those of DeLorme (1945) who reported that a small number of repetitions with high resistance produced strength, whereas a large number of repetitions against low resistance increased endurance. Performing exercises that involve a low number of repetitions on a load that is of high resistance effectively increases strength (Dudley *et al*., 1985; Sale *et al*., 1990) [4, 15]. It is of importance that athletes have high levels of not only strength but also endurance. For this reason many athletes' training programs involve simultaneous strength and endurance training. Nelson *et al*., (1990) [12] conducted a study on previously untrained subjects in which one group performed strength training 4 days/wk for 20 weeks while another group performed the same routine but also performed endurance on the same days. The results indicated that although both groups showed increases in force production, yet the strength-training group showed greater improvements. The same results were also found by (Kraemer *et al*., 1995) [9].

The findings proved that the cardio respiratory endurance of the football players improved significantly by twelve weeks of resistance and concurrent training. These results are conformity with the following findings. Concurrent training improves endurance performance, both with trained cyclists (Paton & Hopkins, 2005) [14] and other trained athletes (Hoff *et al*., 1999; Johnston *et al*., 1997; Millet *et al*., 2002; Paavolainen *et al*., 1999) [7, 8, 11, 13]. Paton and Hopkins (2005) [14] found that 1- and 4-km time trial performance increased could have also been a result of high intensity interval training being employed in addition to resistance training. It has been well documented by Senthil *et al*., (2011) [16] that the effects of concurrent strength and endurance training significantly improved the Cardio-respiratory endurance when compared with control group. Hence, in order to maintain optimal training levels and take advantage of the potential benefits, it is suggested that concurrent resistance and aerobic training sessions not be missed by football players.

Conclusion

As a result of resistance training and concurrent resistance and aerobic training the selected bio-motor abilities such as muscular strength and cardio respiratory endurance of the football players were significantly improved. However, in improving muscular strength resistance training was significantly better than concurrent training whereas, concurrent training was better than resistance training in improving cardio respiratory endurance. The result of the study produced 11.08% of improvement due to resistance training, 6.62% of improvement due to concurrent training on muscular strength. In the case of cardio respiratory endurance, 2.02% of improvements due to resistance training, 11.81% of improvements due to concurrent training were found.

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