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Effect of aerobic training resistance training and concurrent training on vo2 max among college football players

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Abstract
The purpose of the study was to find out the effect of aerobic training resistance training and concurrent training on Vo2 Max among college football players. To achieve this purpose of the study, sixty college football players were selected as subjects who were from the *Mar Athanasius College of Engineering, Kerala*. The selected subjects were aged between 18 to 22 years. They were divided into four equal groups of fifteen each, Group I underwent aerobic training, Group II underwent resistance training, Group III underwent concurrent training and Group IV acted as control that did not participate in any special training apart from their regular football practices. The subjects were tested on selected criterion variable such as vo2 max prior to and immediately after the training period. The selected criterion variable such as vo2 max was determined through using Treadmill. The analysis of covariance (ANCOVA) was used to find out the significant differences if any, between the experimental group and control group on selected criterion variable. In all the cases, 0.05 level of confidence was fixed to test the significance, which was considered as an appropriate. The result of the present study has revealed that there was a significant difference among the experimental and control group on vo2 max.

Keywords: Aerobic training, resistance training, concurrent training, vo2 max, football players

1. Introduction
The primary objective of sports training is to stress various bodily systems to bring about positive adaptation in order to enhance sporting performance. To achieve this objective, coaches and athletes systematically apply a number of training principles including overload, specificity and progression, organized through what is commonly termed periodization. The application of these principles involves the manipulation of various programme design variables including choice of exercise, order of training activities/exercises, training intensity (load and repetition), rest periods between sets and activities/exercises and training frequency and volume in order to provide periods of stimulus and recovery, with the successful balance of these factors resulting in positive adaptation. Aerobic exercise refers to exercise that involves or improve oxygen consumption by the body. Aerobic training increased cardio-respiratory endurance, which in turn increased Vo2 max, because of it increased level of hemoglobin. Resistance training is an integral part of an adult fitness program and of a sufficient intensity to enhance strength, muscular endurance and maintain fat free mass. Resistance training involves exercise in which the muscles exert a force against an external load. It is most commonly referred to as weight training. Such a training program should be individualized, progressive and specific in terms of the way muscles are likely to be used in the chosen sport. Concurrent training is one method that many coaches employ as it consists of training multiple qualities at equal amounts of focus within the same training phase and often within the same workout. The biggest issue that can arise from this sort of programming is that often times the two or three qualities one is looking to enhance end up competing with each other for adaptation. All types of training, whether it is strength training or long distance running, will produce specific responses from the body which trigger gene expression and molecular changes that in turn cause the body to adapt to the training stimulus in order to make us more prepared to tackle this stressor should we need to face it again (our next workout or competition). One of the arguments against concurrent training is that the adaptations that the body's internal environment under goes in response to

the differing training stimuli brought on by the multiple qualities being trained in the training day or training phase are on different ends of the spectrum thus confusing the body as to how it should respond and leading to less than favorable adaptations. This is referred to as the Interference Phenomenon. You can't be an elite powerlifter and an elite marathon runner at the same time. In addition to the arguments about performance outcomes another big issue with concurrent training is the reported overreaching or overtraining that tends to occur when an athlete attempts to cram several training qualities into a workout or training phase, detracting from their recovery time and increasing the amount of training miles they are placing on their body. Interestingly, despite these arguments against concurrent training studies looking at the effects of concurrent training appear to be mixed in regard to the results with some studies showing it to be effective and other studies showing it to be detrimental to strength, power, or endurance adaptations. Of course it is important to take into consideration the subjects in many of these studies, who are often college aged exercise science students with minimal to no training background, thus they may respond in a different manner than someone with a higher training age or more elite in status. The physiological response to dynamic aerobic exercise is an increase in oxygen consumption and heart rate that parallels the intensity of the imposed activity and a curvilinear increase in stroke volume. The cardiovascular system, composed of the heart, blood vessels and blood responds predictably to the increased demands of exercise. With few exceptions, the cardiovascular response to exercise is directly proportional to the skeletal muscle oxygen demands for any given rate of work and oxygen uptake increases linearly with increasing rates of work. A person's maximum oxygen uptake is a function of cardiac output multiplied by the arterial-mixed venous oxygen difference. Cardiac output thus plays an important role in meeting the oxygen demands for work. As the rate of work increases, the cardiac output increases in a nearly linear manner to meet the increasing oxygen demand, but only up to the point where it reaches its maximal capacity. The resting heart rate can be obtained through auscultation, palpation or ECG recordings. When taking heart rate by auscultation, the bell of the stethoscope is placed to the left of the sternum, just above the level of the nipple. The heart beats can be counted. VO2 max (also maximal oxygen consumption, maximal oxygen uptake, peak oxygen uptake or maximal aerobic capacity) is the maximum rate of oxygen consumption as measured during incremental exercise, most typically on a motorized treadmill. Maximal oxygen consumption reflects the aerobic physical fitness of the individual, and is an important determinant of their endurance capacity during prolonged, sub-maximal exercise. The name is derived from V - volume, O2 - oxygen, max - maximum. VO2 max is expressed either as an absolute rate in (for example) liters of oxygen per minute (L/min) or as a relative rate in (for example) milliliters of oxygen per kilogram of body mass per minute (e.g., ml/(kg·min)). The latter expression is often used to compare the performance of endurance sports athletes.

2. Methodology

In the present study, football players were selected as subjects who were from the *Mar Athanasius College of Engineering, Kerala,* was considered as population for the study. A representative sample of 60 football players in the age of 18-22 years was chosen as sample for the study. The selected participants were divided into four groups. Group I underwent aerobic training, group II underwent resistance training, group III underwent concurrent training and group IV act as control group. The experimental groups underwent tweleve weeks of training in their particular workout. For this study dependent variable is vo2 max. Pre-test data were collected two days before the training program and post-test data were collected two days after the training program. The collected data treated with ANCOVA. Level of confidence was fixed at 0.05. If obtained 'F' ratio significant scheffe's post hoc test were used.

2.1 Assessment of Vo2 max

VO2 max (maximal oxygen uptake) was predicted using a sub maximal treadmill test on a motor driven treadmill. The test began at a speed with which each subject could jog comfortably. After 3 minutes when a steady state heart rate (HR) was achieved, the speed and heart rate was recorded VO2 max was predicted using the following formula.

The estimated VO2 max can be calculated in ml/kg/min.

VO2 max = 54.07 – 0.1938 × Body weight + (4.47 × Speed/1.6) – 0.1453 × heart rate + 7.62 × gender

Where: speed = km/h

Gender = 1 for men, 0 for women

Body weight = kg

3. Results

The statistical analyses of Vo2 max due to aerobic training, resistance training and concurrent training have been presented in Table I.

Table 1: Computation of analysis of covariance on vo2 max

		ATG	RTG	CTG	CG	F ratio
Pre Test	Mean	39.42	39.24	38.84	39.38	0.97
	S D	3.87	3.45	3.68	3.94	
Post Test	Mean	45.85	44.21	45.08	39.45	14.83*
	S D	4.12	3.84	3.74	3.89	
Ad Post Test	Mean	45.93	44.57	45.16	39.42	89.64*

The table I shows that the pre-test values on vo2 max for aerobic training, resistance training, concurrent training and control groups were 39.42, 39.24, 38.84 and 39.38 respectively. The obtained 'F' ratio value of 0.97 for pre-test score of aerobic training, resistance training, concurrent training and control groups on vo2 max was less than the required table value of 2.70 for significance with df 3 and 56 at 0.05 level. The post-test means of vo2 max for aerobic training, resistance training, concurrent training and control groups were 45.85, 44.21, 45.08 and 39.45 respectively. The obtained 'F' ratio value of 14.83 for post-test scores of aerobic training, resistance training, concurrent training and control groups was more than the required table value of 2.70 for significance with df 3 and 56 at 0.05 level. The adjusted post-test means of vo2 max for aerobic training, resistance training, concurrent training and control groups were 45.93, 44.57, 45.16 and 39.42 respectively. The obtained 'F' ratio value of 89.64 for adjusted post-test scores of aerobic training, resistance training, concurrent training and control groups were higher than the required table value of 2.72 for significance with df 3 and 55 at 0.05 level. The results of the study indicate that there is a significant difference between vo2 max for aerobic training,

resistance training and concurrent training after respective training for a period of 12 weeks, Scheffe's post-hoc test was applied and the results are presented in Table –II.

Table 2: Scheffe's test for the adjusted post-test paired means of vo2 max

Adjusted Post Test Means				Mean Difference
ATG	RTG	CTG	CG	
45.93	44.57			1.36*
45.93		45.16		0.77
45.93			39.42	6.51*
	44.57	45.16		0.59
	44.57		39.42	5.15*
		45.16	39.42	5.74*

The results presented in table II shows that the mean difference between aerobic training group and resistance training group was 1.36, aerobic training group and control group was 6.51, resistance training group and control group was 5.15 and concurrent training group and control group was 5.74, which were higher than the required confidence interval value of 0.94. However, all the experimental groups have significant difference when compare to the control group and also there was a significant difference between aerobic and resistance training group. There was no significant difference between the aerobic resistance training group and concurrent training group and also resistance training group and concurrent training group.

4. Discussion

The results of analysis of covariance on vo2 max showed that there was a significant difference existed between control group and aerobic training, resistance training and concurrent training groups. Thus, tweleve weeks of experimental treatment reduction in vo2 max of the college boys compared to control group, aerobic training was found to be significantly better than resistance training and concurrent training. The above findings are in consonance with the study conducted by Millet and others, Zabiholah Tarasi and others, Wilson and others and Ferrauti, Bergermann and Fernandez-Fernandez.

5. Conclusion

This well-designed study reveals constructive insights for personal trainers who train some clients with cardiovascular and resistance exercise within the same session. When the sequence involves aerobic exercise followed by resistance training, the personal trainer may be well advised (from results of this study) to attempt to emphasize different muscle groups during the aerobic training as those conditioned in the resistance exercise. There was no significance difference in the intensity of aerobic exercise completed prior to the subsequent resistance workout; so this decision can be made exclusively on the cardiovascular goals of the client for that workout. Should the trainer wish to ensure no compromise of strength training output in a concurrent workout session, another educated option is to perform the resistance exercise first, followed by the aerobic training.

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