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# 9. Effect of Concurrent Strength and Endurance Training on Selected Physiological Variables

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***Abstract:***

*The purpose of the study was to find out the effect of concurrent strength and endurance training on selected physiological variables namely Cardio-respiratory endurance and Resting pulse rate. To achieve this purpose forty students studying in the department of physical education and sports sciences, Annamalai University, Annamalai Nagar, Tamil Nadu and India were selected as subjects at random. Their age ranged between eighteen to twenty-two years.*

*The selected subjects were divided into two equal groups of twenty each namely concurrent strength and endurance training group and control group. The experimental group has undergone twelve weeks of concurrent strength and endurance training, whereas the control group maintained their daily routine activities and no special training was given. The subjects of the two groups were tested on selected variables namely Cardio-respiratory endurance and Resting pulse rate standardized tests, namely Cooper's 12-minute walk/run test and counting on radial artery/minute at prior and immediately after the training period. The collected data were statistically analyzed through analysis of variance (ANOVA) to find out the significant difference, if any between the groups. The .05 level of confidence was fixed to test the level of significance which was considered as an appropriate. The results of the study showed that there were significant differences exist between concurrent strength and endurance training group and control group. Also, concurrent strength and endurance training group showed significant improvement on Cardio-respiratory endurance and Resting pulse rate compared to the control group.*

***Keywords:***

*Concurrent strength and endurance training, Cardio-respiratory endurance and Resting pulse rate, Analysis of variance (ANOVA).*

## 9.1 Introduction:

The sequential exercise regime is referred to as 'concurrent training'. Concurrent strength and endurance training is undertaken by numerous athletes in various sports in an effort to achieve adaptations specific to both forms of training.

Literature findings to date, investigating the neuromuscular adaptations and performance improvements associated with concurrent strength and endurance training (referred to as concurrent training) have produced inconsistent results. Some studies have shown that concurrent training inhibits the development of strength and power, but does not affect the development of aerobic fitness when compared to either mode of training alone. Other studies have shown that concurrent training has no inhibitory effect on the development of strength and endurance.

### 9.1.1 Cardio-Respiratory Endurance:

Cardio-respiratory endurance of the ability to carry a work load for a relatively prolonged period [1]. The endurance is that enables the heart, blood vessels and lungs to receive oxygen and take it to the muscular and to do it as often and effortless as possible [2].

### 9.1.2 Strength and Endurance Adaptions:

Strength and endurance training regimes represent and induce distinctly different adaptive responses when performed individually. Typically, strength-training programs involve large muscle group activation of high-resistance low-repetition exercises to increase the force output ability of skeletal muscle [3].

In contrast, endurance-training programs utilize low- resistance, high-repetition exercises such as running or cycling to increase maximum $O_2$ uptake ($VO_{2\ max}$). Accordingly, the adaptive responses in skeletal muscle to strength and endurance training are different and sometimes opposite [4].

Strength training has been reported to cause muscle fibre hypertrophy, associated with an increase in contractile protein, which contributes to an increase in maximal contractile force [3].

Strength training also reduces mitochondrial density and suppresses oxidative enzymes activity which can cause impede endurance capacity, but has minimal impact on capillary density or in the conversion of muscle fibre types from fast twitch (type II fibres) to slow twitch (type I fibres).

In contrast, endurance training usually causes little or no muscle fibre hypertrophy, but it does induce increases in mitochondria content, citric acid enzymes, oxidative capacity and the possibility of muscle fibre conversion from fast twitch to slow twitch.

Many competitive endurance athletes incorporate resistance training into their training in a hope to improve endurance performance. However, as previously mentioned adaptations to exercise are generally considered to be specific to the training type of stimulus [5].

Although, many adaptations are specific to the type of training, some changes that occur with resistance training could influence endurance performance, which include: muscle fibre transformations and muscle fibre (type I) hypertrophy, which may alter fibre recruitment patterns and help prevent muscle fatigue, as less motor units need to be activated for the same work load [6].

### 9.1.3 Statement of the Problem:

The purpose of this study was to investigate the effect of concurrent strength and endurance training on selected physiological variables for physical education students of Annamalai University, Chidambaram, Tamilnadu and India, on age group ranged between eighteen to twenty-two.

## 9.2 Materials and Methods:

The purpose for this study subjects were randomly selected from Annamalai University, Chidambaram. A total of forty subjects was selected at random and they were divided into two equal groups that is experimental and control groups, each group consist of twenty subjects, their age ranged from eighteen to twenty-two.

The experimental group has undergone concurrent strength and endurance training such as incline leg press, bench press, jump to box, jump from box, alternate leg squat, alternate leg hops in place, jogging and cycling three days in a week for the period of twelve weeks and the control group was not undergoing concurrent strength and endurance training. To find out the Cardio-respiratory endurance and Resting pulse rate the investigator conducted the Cooper's 12-minute walk/run test and counting on radial artery/minute.

Testers' competency, subject reliability and reliability of tests were established by using test and retest method and the reliability coefficient were found to be satisfactory high. The data were analyzed using analysis of variance (ANOVA) for determine the effect of concurrent strength and endurance training on selected physiological variables of Cardio-respiratory endurance and Resting pulse rate of students of the department of physical education and sports sciences, Annamalai University, Annamalai Nagar, Tamil Nadu and India on the age group between eighteen to twenty-two.

### 9.2.1 Selection of Variables and Tests:

The research scholar reviewed the available scientific literature pertaining to available the present study, the following variables were selected.

**Table 9.1: Selection of Variables and Tests**

| Sr. No. | Variables | Test Items |
|---|---|---|
| 1. | Cardio-respiratory endurance | Cooper's 12-minute walk/run test |
| 2. | Resting pulse rate | Counting on radial artery/minute |

### 9.2.2 Statistical Techniques:

Data were collected from the both groups, the selected variables on Cardio-respiratory endurance and Resting pulse rate was statistically examined by using the "F" ratio used to find out the significance difference between experimental group and control group, the level of significance was fixed at 0.05 level of confidence. The Scheffe's Post-hoc test used to find out the significant difference between the means if any.

### 9.3 Result and Discussion:

Within the limitations of the study the following conclusions appeared and justified as per the result obtained. The mean difference of the criterion measures for the control and experimental groups presented in tables. The calculated value of F ratio (0.445) was lesser than the table value of 4.08 at 0.05 level. Hence it was not significant.

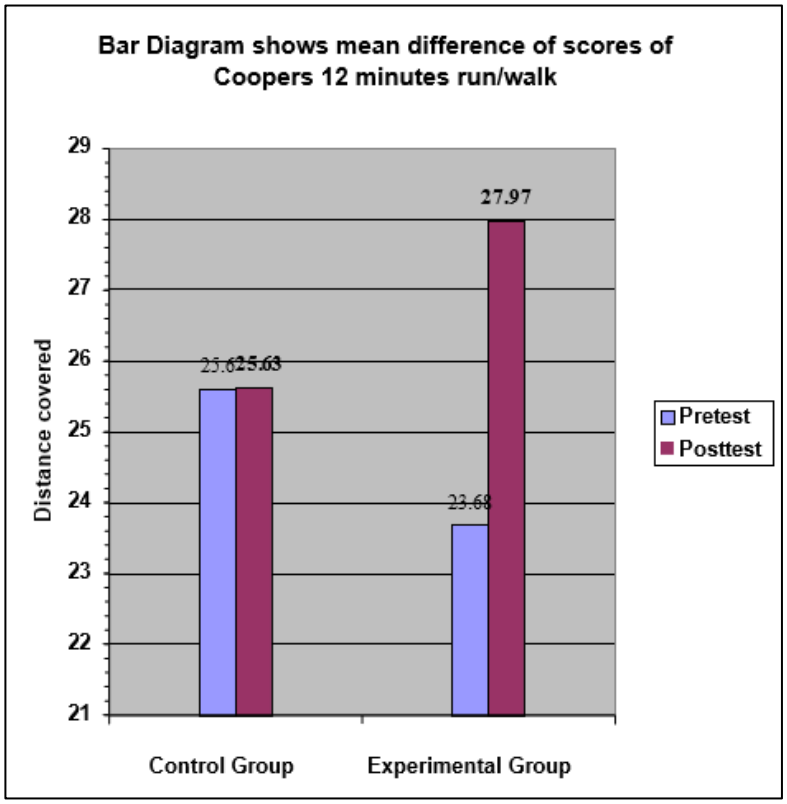
Therefore, the pretest showed that there was no statistical significance difference between control and experimental group scores of Coopers 12-minute walk/run test. The calculated value of F ratio (15.903) was greater than the table value of 4.08 at 0.05 level.

Hence it was significant. Therefore, the post test showed that there was statistical significance difference between control and experimental scores of Coopers 12-minute walk/run test.

**Table 9.2: One way analysis of variance (ANOVA) for pretest and post test scores of Coopers 12 minutes' walk/run test of control and experimental group.**

| Vertical jump test | Sources of variance | Sum of squares | Degrees of freedom | Mean squares | F |
|---|---|---|---|---|---|
| | Between | 0.0511 | 1 | 0.0511 | |
| Pre test | Within | 4.369 | 38 | 0.11497 | 0.445 |
| | Total | 4.4201 | 39 | | |
| | Between | 0.229 | 1 | 0.229 | |
| Post test | Within | 0.547 | 38 | 0.0144 | 15.903 |

Table value of (1, 38) at 0.05 level was 4.08

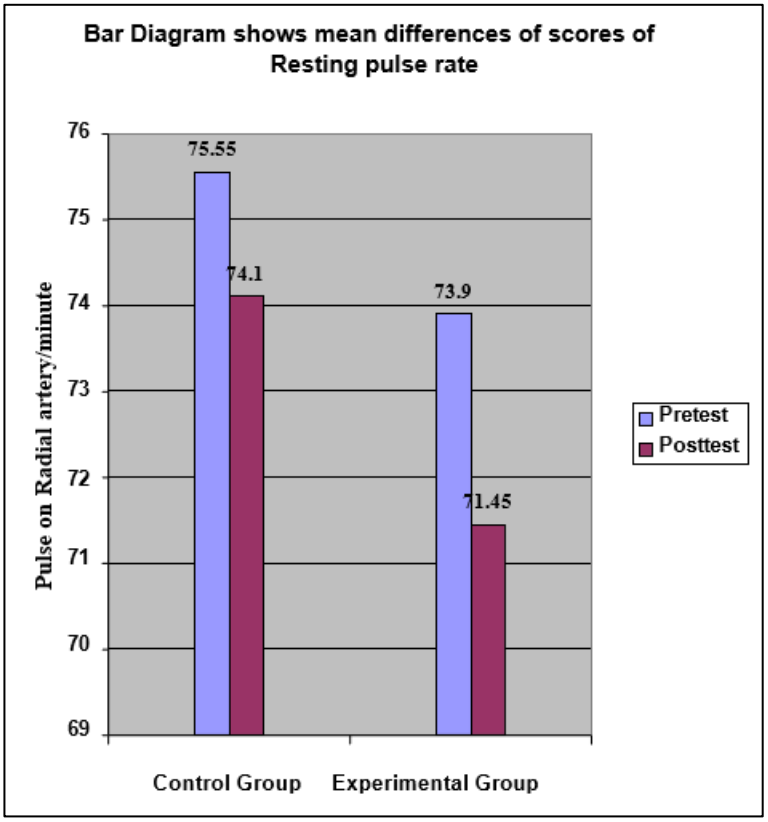


The mean difference of the criterion measures for the control and experimental groups presented in tables.

**Table 9.3. One way analysis of variance (ANOVA) for pretest and post test scores of Counting on radial artery/minute of control and experimental group**

| Bent Knee Sit Ups test | Sources of variance | Sum of squares | Degrees of squares | Mean squares | F |
|---|---|---|---|---|---|
| Pre test | Between | 21.025 | 1 | 21.025 | |
| | Within | 591180.75 | 38 | 6436.0197 | 0.00135 |
| | Total | 232.775 | 39 | | |
| | Between | 60.625 | 1 | 60.025 | |
| Post test | Within | 172.75 | 38 | 4.546 | 13.204 |
| | Total | 232.775 | 39 | | |

Table value of (1, 38) at 0.05 level was 4.08.



The calculated value of F ratio (0.00135) was lesser than the table value of 4.08 at 0.05 level. Hence it was not significant.

Therefore, pretest showed that there was no statistical significance difference between control and experimental group scores of Counting on radial artery/minute.

The calculated value of F ratio (13.204) was greater than the table value of 4.08 at 0.05 level. Hence it was significant.

Therefore, posttest showed that there was statistical significance difference between control and experimental scores of Counting on radial artery/minute.

It can be observed from table 3 that the Cooper's 12-minute walk/run test scheffe's confidence interval (CI) value at 0.05 levels for post – test score was 1.317.

The mean difference between control and experimental group (2.34) was above the obtained value. 1.317 at 0.05 significance level.

On the whole form overall result for Cooper's 12-minute walk/run test, it was inferred that concurrent strength and endurance training had significant effect on increasing the cardio-respiratory endurance of experimental group.

The Counting on radial artery/minute test scheffe's confidence interval (CI) value at 0.05 levels for post – test score was 160.93.

The mean difference between control and experimental groups (-2.45) was below the obtained value. 160.93 at 0.05 significance level.

On the whole form overall result for Counting on radial artery/minute test was inferred effect on decreasing the Resting pulse rate of experimental group.

**Table 9.4: Scheffe's post-hoc test: Test of significance between pair of post-means of Cooper's 12-minute walk/run and counting on radial artery/minute scores**

| Test | Experimental group | Control group | Mean Difference | Confidence Interval |
|---|---|---|---|---|
| Cooper's 12 | | | | |
| minute walk/run Counting on radial | 27.97 | 25.63 | 2.34 | 1.317 |
| artery/minute | 71.45 | 73.9 | -2.45 | 160.93 |

Cooper's 12-minute walk/run test Scheffe's Confidence Interval at 0.05 level = 1.317 Counting on radial artery/minute test Scheffe's Confidence Interval at 0.05 level = 160.93

## 9.4 Conclusion:

The finding of this study indicated that the effects of concurrent strength and endurance training showed significantly improved the Cardio-respiratory endurance and reduced Resting pulse rate when compared with control group.

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