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# The Effect of Two Types of Concurrent Training on $Vo_{2max}$, Maximal Strength and Body Fat Percentage in Young Men

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## Abstract

**Introduction:** The purpose of this study was to evaluate the effect of two types of concurrent training on $Vo_{2max}$, maximal strength and body fat percentage in young men.

**Methods:** 39 healthy young men were randomly divided into three equal number groups (13 subjects/group) including; endurance-resistance concurrent training (ERCT), resistance-endurance concurrent training (RECT) and control (CON). The subjects of ERCT and RECT groups performed endurance and resistance training with the same intensity and duration three times a week for eight weeks. The endurance training program included aerobic training on treadmill from 55 % of maximum heart rate (HRmax) and 25min in the first two weeks to 85% HRmax and 45 minutes in the last two weeks. The resistance training program included free weight training with 50% of 1-RM in first two week to 80% in last two week. The time of training in endurance component was the same as the resistance component of concurrent training. CON group did not participate in any exercise training and did daily routine activities. Estimated $VO_{2max}$ and upper and lower extremities maximal strength and body fat percentage was measured before and 72h after the last training session. Analysis of variance (ANOVA) with repeated measures test was used for statistical analysis. The significant level was set at 0.05 in all statistical analysis.

**Results:** The study results showed a significant increase in $VO_{2max}$, body fat percentage, lower and upper extremities maximal strength in both ERCT and RECT groups when compared to baseline values ($p \leq 0.05$). However, no significant difference was found between the ERCT and RECT groups in any of variables ($P \leq 0.05$).

**Conclusion:** According to the results of this study, endurance training before resistance or vice versa during concurrent training did not have significant effect on aerobic power, maximal strength and body fat percentage of untrained healthy men.

**Keyword:** Concurrent Training, Muscle Strength, Fat Percentage, $Vo_{2max}$

## Introduction

Muscular adaptation takes place in the long-term physical activities to maintain cell haemostasis during future sessions (1). Although it has been argued that each part may interact with each other adaptations (2), In general, endurance and resistance training independently result in different physiological adaptations (3, 4). Nevertheless, it seems that the use of several energy-generating systems and the simultaneous implementation of different types of exercises, which are referred to as concurrent training, in comparing performing one energy system alone, can cause to rehabilitate post-atrophic changes (5, 6), to improve body composition of MS patient (7) to relief the effects of aging (8, 9) to prevent the premature creation of many of the diseases, and to gain physiological and metabolic adaptations, (10). In recent decades, the comparability of endurance and strength training together and the effect of different methods of concurrent training on physiological and biochemical variables of the human body are considered by researchers. Studies have shown that athletes can perform both endurance and strength training to achieve adaptations of both training modalities, which may increase cardiovascular conditioning and also improving muscular strength. For example, it is reported that concurrent strength and endurance training increases both muscle strength and maximal oxygen consumption (1, 11). The direction of the research results regarding the effects of concurrent training as a way to improve strength and endurance performance is unclear. Some studies have shown that aerobic exercise activity reduces maximal strength (12, 13), hypertrophy (12, 14), and power (12, 13) which potentially occur during resistance training method. This is done through the Akt-mTOR- S6K cascade and by interfering with the AMPK- PGC-1a signalling pathway (15). Other researchers have seen similar strength improvement with concurrent training (11). It seems that the concurrent training effect on aerobic capacity improvement when compared to aerobic exercise alone indicates that $VO_{2max}$ is not affected by competitive adaptations (16) and may even be helpful in increasing the contribution of type IIa fibers (17). However, Jones *et al.* reported that performing endurance exercises before strength exercises impaired the performance of resistance training (18). Considering that the effect of different order of concurrent endurance and resistance training is less considered, and given its impact on the maximal strength, aerobic power and body composition has created a lot of questions, this study aimed to evaluate the effects of different methods of concurrent endurance and resistance training on $vo_{2max}$, maximal strength and body fat percent in healthy untrained men.

## Methods

Thirty- nine healthy men signed a consent form which was approved by Ethic Committee of Kurdistan University of Medical Sciences and received details of the possible risks of participation in the exercise training protocol. The subjects completed the PAR-Q questionnaire for their health condition assessment. The inclusion criteria for the study was lacking the history of chronic diseases, have regular exercise last year, and have smoking or alcohol consumption. The subjects were randomly assigned into three groups of endurance-resistance concurrent training (ERCT) resistance-endurance concurrent training (RECT) and control (CON). The characteristic of the participants are presented in Table 1. Before the starting training, 1RM of the subjects were measured by free weights. In which the maximum weight that the subjects was able to move was recorded as 1RM person in that movement. Experimental groups carried out both endurance and resistance training in each session, concurrently. Training programs were performed for eight weeks, three times a week in the evening on Sundays, Tuesdays and Thursdays. The endurance training program included aerobic training on treadmill from 55 % of maximum heart rate (HRmax) and 25min in the first two weeks to 85 % HRmax and 45 minutes in the last two weeks. The resistance training program included exercises with weights including bench press, biceps and triceps flexion-extension with weights, underhand cable pull-down, leg press, scot and sit-ups, which were performed with 50 to 80 % of 1- RM. The intensity of resistance training was increased by 10 % every two weeks. The time of training in endurance component was the same as the resistance component of concurrent training. In order to imply likely improvements, the 1- RM measurement was repeated in the last of Fourth week and the new 1- RM was calculated. ERCT and RECT group's subjects were asked to warm up for 10 min by voluntary running. The endurance training program was performed first in the ER group and the resistance training program was performed first in the RE group. Ten minute active rest interval was set between the endurance training and strength training. The endurance training was carried out on standard treadmills (RUN700, TechnoGym, Italy) and the resistance training was performed with standard weights and machines (Ningjin Xinrui, Shandong, China). The total time of training in endurance component was the same as the resistance component of concurrent training. Control group only participated in daily activities. Anthropometric measurements were performed one day before random assignment of individuals of all groups. The height and weight was measured by using standard scale with integrated measuring rod (Secca 704s, Germany). The body fat percentage was also measured by the skinfold method (Harpenden Caliper, Betty, England) in pectoral, abdominal and thigh points and it was estimated by replacing the Jackson and Pollock body fat percentages equation (19). Subjects were asked to perform the maximal Bruce protocol on treadmill (20) in order to estimating $VO_{2max}$. Bench press (BP) and leg press (LP) was measured via the free weight in order to upper and lower body maximal strength assessment, respectively. All above measurement was done before the training program and repeated 72h after the last training session. This 3 day period was set in order to return the effects of the last training session to the resting state. The Shapiro-Wilk test was used to determine the normality of distributions and Leven test for homogeneity of variances. Because all variables were distributed normal and had homogeneity of variances, then analysis of variance (ANOVA) with repeated measures test were used to examine the likely differences. In case of significant differences, Bonferroni's post hoc test was used for pairwise comparison. Paired-sample t student test was also used to compare the pre and post-test values in each group. SPSS 21.0 (Chicago, USA) software was used for statistical analysis. The significant level was set at 0.05 in all statistical analysis.

## Results

Because the the subjects of three groups were homogeneous based on the body composition, the pre-test of anthropometric data were very similar. Then one-way ANOVA results didn't showed any significant differences in pre-training values of age, height, weight and BMI between the groups ($P \geq 0.05$). ERCT, RECT and Con group's physical characteristics was shown in table 1. Data analysis showed significant differences in maximum oxygen consumption ($VO_{2max}$) between the groups ($P=0.003$). Also, significant differences was seen in time (training) and time × group interaction for both $VO_{2max}$ and body fat percentage ($P \leq 0.05$). Bonferroni post hoc test showed significant difference between ERCT and CON for $VO_{2max}$ and Body fat percent. Furthermore, a comparison within the group showed significant differences in ERCT and also RECT groups in case of both above mentioned variables (see table 2). Furthermore, the results showed that after ERCT and RECT significant increases was seen in BP and LP maximal strength ($P \leq 0.05$). However, Significant differences wasn't seen between the ERCT and RECT groups ($P \geq 0.05$). Variable results of the study were shown in table 2.

**Table 1.** Physical sharacteristics of subjects at the start of the study

| Variable | ERCT | RECT | CON | F | Sig |
|---|---|---|---|---|---|
| Age(year) | 22.00±3.00 | 21.66 ±2.08 | 22.61±3.05 | 0.551 | 0.583 |
| Height(cm) | 177.17±4.85 | 174.63±3.48 | 176.89±4.00 | 1.124 | 0.340 |
| Weight (kg) | 68.72±4.38 | 68.70±3.35 | 71.85±4.14 | 2.069 | 0.146 |
| BMI(kg/m$^2$) | 21.88±1.01 | 22.54±1.28 | 22.95±0.80 | 2.593 | 0.093 |

Data are presented as M±SD. BMI; body mass index.

**Table 2.** RM- ANOVA statistical results in ERCT, RECT and CON groups for $VO_{2max}$ and body fat percent before and after the training program

| Variable | Group | Pre-training | Post-training | Sig. Between Groups | Sig. Time | Sig. T×G |
|---|---|---|---|---|---|---|
| $VO_{2max}$ (ml.kg$^{-1}$.min$^{-1}$) | ERCT | 37.79 ±11.09 | 46.03 ±13.68# | 0.003* | 0.001* | 0.002* |
| | RECT | 38.74 ±16.30 | 44.80 ±17.69# | | | |
| | CON | 37.95±10.22 | 38.28±11.60 | | | |
| Body fat (%) | ERCT | 15.70 ±5.21 | 12.75 ±5.00# | 0.184 | 0.001*† | 0.024* |
| | RECT | 17.57 ±6.58 | 13.73 ±4.09# | | | |
| | CON | 16.92±5.74 | 16.71±6.49 | | | |
| Bench press maximal strength (kg) | ERCT | 67.5 ±14.00 | 85.6 ±15.2# | 0.021* | 0.009* | 0.041* |
| | RECT | 71.8 ±18.4 | 87.3 ±20.5# | | | |
| | CON | 69.6±16.5 | 70.9±13.5 | | | |
| Leg press maximal strength (kg) | ERCT | 115.4 ±45.7 | 174.3 ±58.8# | 0.020* | 0.011* | 0.028* |
| | RECT | 123.4 ±51.5 | 194.3 ±78.3# | | | |
| | CON | 119.6±38.6 | 121.7±41.3 | | | |

Data are presented as M±SD. T×G= interaction effect of Tome × Group. *= Significantly different at 0.05 level (α=0.05); †= significantly different at 0.01 level (α=0.01). #=significant difference between the pre and post-training.

## Discussion

The aim of present study was to investigate the effects of different methods of concurrent endurance and resistance training on $VO_{2max}$, maximal strength and body fat percent in healthy untrained men. After the training protocols we found a significant improvement in $VO_{2max}$ in ERCT (~22%) and RECT (~15%) groups. Also, body fat percent decreased significantly in both ERCT and RECT groups after 8 weeks of training. In line with current research, McNeil *et al.* (2014) showed that concurrent training independent of the execution of its endurance and resistance components results in an increase in $VO_{2peak}$ and maximum isometric strength, but does not affect the activity of mitochondrial enzymes (1). It is believe that more adaptation occurs in lower extremities' 1RM with resistance and endurance training sequence. This may be due to improve the musculoskeletal economy, with improvement in strength and reduction of electromyographic activity in a certain workload (21). In a meta-analysis study which analysed the results of 21 studies that were conducted on concurrent training and interactions between its endurance and resistance components, showed that the concurrent training produced similar increases in maximal strength and $VO_{2max}$ as with aerobic and resistance activities alone (16). According to present study results, the priority of the endurance and resistance components of the concurrent training did not create a significant difference in the $VO_{2max}$, maximal strength and body fat percentage. These results are consistent with the findings of McNeill *et al.* However, the subjects of the research were women and men, but men were used in this study. When performed immediately after each other, the exercise order does not differ significantly in body composition, maximum strength or aerobic capacity improvement. Nowadays many non-athletes and competitive athletes are doing endurance and resistance training in their daily training programs routinely. According to our study results we can recommend to inactive people doing concurrent endurance and resistance training regardless to exercise order. However, our research has examined the effects of two types of concurrent training by different exercise pprotocol, certain intensity, and duration. It is likely the examining of the effects of concurrent training protocol with different intensity and duration would have different results.

## Conclusion

According to the results of this study, there aren't significant differences in maximal strength, body composition and aerobic capacity between RECT and ERCT. However, we observed the beneficial effects of both concurrent methods on above mentioned variables. It seems that further research is needed to determine the degree of interference between the endurance and resistance components of the concurrent training. Also, the effect of the order of these components on biochemical and metabolic factors can provide many subjects for future research.

## Ethical issues

No applicable.

## Authors' contributions

All authors equally contributed to the writing and revision of this paper.

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