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# Effect of Resistance Training on Aerobic Fitness in Healthy Young Individuals

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**Abstract:** ***Background:Cardiovascular fitness, which is health related physical fitness component, is the ability of the circulatory and respiratory system to supply oxygen during sustained physical activity. By use of various exercise protocols, $VO_{2max}$ and thereby aerobic fitness can be improved. Resistance training is currently recommended for its effects on maintenance of strength, muscle mass, aerobic capacity, and prevention or rehabilitation of musculoskeletal problems. Aim of Study:To monitor the effect of resistance training on the exercise capacity, measured by $VO_{2max}$, in healthy young untrained individuals. Study Design,Sample Size and Sampling: A Comparative study, 20 subjects by convenient samplingmethod Methods: Baseline parameters of $VO_{2max}$ and RPP were taken for each subject. Subjects were randomly divided into two groups [Resistance group (RG) and Control group(CG)]. In RG, eight resistance exercises, divided into two parts, were given with 4 sets of 10RM, performing both parts on alternate days. Chest press, retractors, arm extension, quadriceps, abdominal curl-ups, elbow flexion and extension, lower abdominals were included. After training, again $VO_{2max}$ and RPP were taken. In CG, no exercise was given. Results: Statistical analysis was done using SPSS 16.0.Data were parametric hence un-paired t-test was used. There was statistically significant increase in the $VO_{2max}$(p=0.001)and decrease in RPP (p=0.006) values in RG compared to CG, suggesting increased aerobic fitness. Conclusions:Resistance training lead to significant improvement in the $VO_{2max}$ and RPP, suggesting increased aerobic capacity of the sedentary individuals.***

**Keywords:** Resistance training, aerobic fitness, 10 Repetition Maximum, Rate Pressure Product

## 1. Introduction

Physical fitness has typically been defined as a set of attributes or characteristics that people have or achieve that relates to the ability to perform physical activity. Cardiovascular endurance or fitness, which is health related physical fitness component, is the ability of the circulatory and respiratory system to supply oxygen during sustained physical activity. [1, 2]

By using several methods, including percentages of maximal oxygen consumption ($VO_{2max}$), oxygen consumption reserve ($VO_2R$), heart rate reserve (HRR), maximal heart rate ($HR_{max}$), or metabolic equivalents (METs), the intensity of the physical fitness can be prescribed.[1] Among these, $VO_{2max}$, representing aerobic power, is the best objective measure of maximal cardio-respiratory endurance capacity.[3]

$VO_{2max}$ is defined as the highest rate of oxygen consumption attainable during maximal or exhaustive exercise.[3]By use of various exercise protocol, $VO_{2max}$ can be improved and thereby cardio-respiratory fitness. Myocardial oxygen uptake and myocardial blood flow are directly related to the product of heart rate and systolic blood pressure. This value is referred as the double product, also known as Rate Pressure Product (DP or RPP=HR × SBP). With static or dynamic resistance or upper body work, the rate pressure product is elevated, indicating much higher cost to the heart.[4,5]

Resistance exercise is any form of active exercise in which dynamic or static muscle contraction is resisted by an outside force applied manually or mechanically.[6] Resistance training increases muscle strength by increasing motor unit recruitment or decreasing neurological inhibition or increasing firing frequency of the motor units. Early gains in strength appear mainly due to integration of the neural factors, but later long term strength gains are the result of increase in the muscle hypertrophy.[3] There is increase in the lean body mass and improved quality of life.[7] Several laboratories suggest that measurement of aerobic capacity in elderly subjects may be compromised by skeletal muscle weakness and strength loss.[8]Frontera et al observed increase in $VO_{2max}$ following 12 weeks of resistance training in the elderly, using 1 repetition maximum (1-RM) which is the maximum weight that can be used to complete 1-RM during a given exercise.[9]

Review of available literature suggests that the effects of isolated resistance training need to be evaluated in various populations. Therefore, this study is conduced to compare the effect of resistance training on aerobic fitness and rate pressure product on healthy untrained young individuals.

## 2. Materials and Methods

From the tertiary care hospital, 20 subjects (80% of power of study) were recruited by convenient sampling technique.Ethics approval was obtained by Institutional Review Board.

Untrained healthy individuals with age between 18 to 35 years of both genders and with normal BMI [10]were recruited. Individuals with any orthopedic, cardio-respiratory or neuromuscular disease that limit their exercise performance and individuals using any medicines were excluded. Individuals with any previous training were also excluded.

Each subject was explained the whole study and purpose of the study. A written informed consent for voluntary participation was obtained from each subject. On 1st day, baseline parameters such as age, weight, height, heart rate, blood pressure and $VO_{2max}$ by Rockport test were taken.

To measure the Rate Pressure Product, the blood pressure and pulse rate of each subject was measured after giving the resting position for the 5 min of the rest. Rate Pressure Productis calculated by equation RPP=HEART RATE × SYSTOLIC BLOOD PRESSURE. [4,5]

All subjects were randomly divided into 2 groups, Resistance Group (RG) and Control Group (CG), 10 individuals in each group.In RG, eight resistance exercises, divided into two parts, were given. There were 4 sets of 10RM and both parts were performed on alternate days. Chest press, retractors, arm extension, quadriceps, abdominal curl-ups, elbow flexion and extension, lower abdominals were included. . In CG, no exercise was given. After 6 weeks of training (6 days/week), again $VO_2$max and RPP were taken.

- Warm up phase : - Bilateral Triceps, Quadriceps, Hamstrings and Calf muscles stretching
- Conditioning phase : - Following exercises and MacQueen resistance training protocol[13] was used

**Figure 1:** Resistance training

Cool down phase :- Bilateral Triceps, Quadriceps, Hamstrings and Calf muscles stretching.

**Table 1:** Resistance training protocol

| Weeks | Frequency[11,12] | Intensity[13] | Time/ Sets | Type[7] |
|---|---|---|---|---|
| 1st-2nd week | 3 Days for Type-1 and 3 Days for Type-2 | Start with 10 RM and progress to 10 RM every 1-2 weeks | 4 sets of each exe with 10 RM/day | 1)Chest press-1<br>2)Arm extension-1<br>3)Leg extension-1<br>4)Abdominal curl ups-1<br>5)Elbow flexion-2<br>6)Elbow extension-2<br>7)Retractors-2<br>8)Lower Abdominals-2 |
| 3rd-4th week | | | 4 sets of each exe with new 10 RM/day | |
| 5th-6th week | | | 4 sets of each exe with new 10 RM/day | |

## 3. Results

The present study studied the effect of resistance training of six weeks on aerobic fitness in healthy young individuals. Data was analysed using statistical software SPSS version 16. Before applying statistical tests, data was screened for normal distribution. All the outcome measures were analysed at baseline and after 6 weeks of training for both groups using relevant statistical test at α value 0.05. Outcome measures were analysed within group as well as between groups.

There were 6 males and 4 females in RG and 5 males and 5 females in control group. The mean age was 22.5±1.64 and 26.16±4.9 years in RG and CG, respectively. The mean BMI was 20.69±1.74 and 21.04±1.88 kg/$m^2$ in RG and CG, respectively.

To analyse effect on **$VO_{2max}$** within the resistance group with 6 weeks of exercise training, paired t-test was used as the data were found to be normally distributed. There was statistically significant increase in $VO_{2max}$ as compare to baseline within the RG with p value <0.001.To know the difference on $VO_{2max}$ between the resistance and control groups, unpaired t-test was used as the data were found to be normally distributed and was found to be statistically significant (t= 7.978, p=<0.001).

**Table 2:** p values of $VO_{2max}$ and RPP for both RG and CG

| | $VO_{2max}$ (p value) | RPP (p value) |
|---|---|---|
| Within RG | <0.001 | 0.007 |
| Between RG and CG | <0.001 | 0.012 |

For RPP, to know effects within resistance group, paired t-test was used and it was found to be statistically significant decrease in RPP after 6 weeks of training (p= 0.007). For comparison of RPP between RG and CG, unpaired t-test was used as the data were found to be normally distributed and was found to be statistically significant (t=2.811, p=0.012).

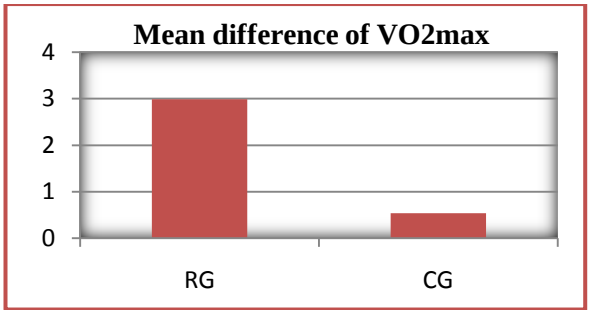


**Figure 2:** Mean difference of VO2max

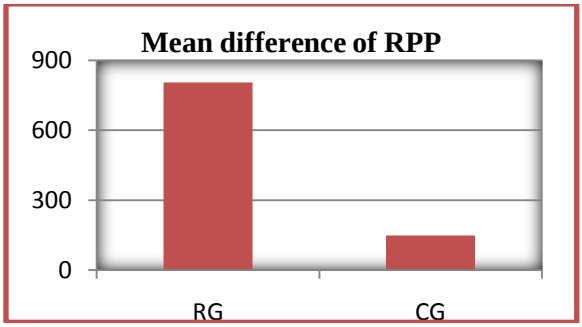


**Figure 3:** Mean difference of RPP

## 4. Discussion

The current study was conducted to know the effect of the resistance exercise on the aerobic fitness ($VO_{2max}$) and the Rate Pressure Product in healthy young sedentary individuals. In this study, there was a statistically significant difference within the resistance group for the $VO_{2max}$ and Rate Pressure Product measures. The statistically significant difference was also found between the RG and CG for both $VO_{2max}$ and RPP and showed that there was improvement in the aerobic fitness in resistance group compared to control group after 6 weeks of training.

In this study, the improvement in $VO_{2max}$ for the resistance group was 17.1%, suggesting greater.

Increased $VO_2$max after training may be due to an increase in the capacity of the cardiovascular system to deliver oxygen (increased cardiac output) and of the muscles to use that oxygen (greater a-v$^-O_2$ difference).[2]The effect on RPP by exercise is thought to be due to an altered autonomic balance with an increased stroke volume, leading to an increase in functional capacity.

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