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RESEARCH ARTICLE

# Effect of high and low intensities of aerobic training on rate pressure product

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## ABSTRACT

**Background:** Aerobic exercise reduces body fat and improves weight control, increases high-density lipoprotein and $Vo2_{max}$ (maximal oxygen consumption), decreases resting heart rate (RHR) and systolic blood pressure (BP), which in turn reduces rate pressure product (RPP). Although aerobic exercise improves cardiac fitness, the relative merits of different intensities of aerobic exercise in improving cardiac fitness are still uncertain. **Aims and Objectives:** The present study was conducted to know the effect of high- and low-intensity aerobic training on RPP. **Materials and Methods:** A total of 80 sedentary men (18–40 years) were randomized into two equal groups (high-intensity and low-intensity group). The high- (80% HR max) and low-intensity (50% HR max) groups underwent aerobic exercise training using bicycle ergometer (COSCO) at 900 kpm and 540 kpm, for 15 min/day and 30 min/day, respectively, 5 days a week, for a period of 12 weeks. RHR and BP of each subject were recorded using digital sphygmomanometer (ACCUMAM) before and after intervention. **Results:** After 12 weeks of aerobic training, both the exercise groups had improvement in cardiac fitness, but high-intensity group had a significant ($P < 0.05$) improvement in cardiac fitness, i.e., reduction in RPP (100.18–80.14) than low-intensity group (102–100.6). **Conclusion:** High-intensity aerobic exercise is effective in improving cardiac fitness.

**KEY WORDS:** Bicycle Ergometer; Body Fat Percentage; Rate Pressure Product; Body Mass Index

## INTRODUCTION

Aerobic exercise is defined as "any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature." It is also defined as exercise that increases the need for oxygen. Aerobic exercise is used interchangeably with the terms cardiovascular exercise, cardiorespiratory exercise, and cardio.[1]

Regular aerobic exercise improves health in the following ways: Reduces body fat and improves weight control and resting blood pressure (BP) (systolic and diastolic) blood supply to the muscles, reduces insulin resistance, and improves heart and lung functions.[2]

Basic aerobic endurance training that follows the ACSM's recommended guidelines[3] for cardiorespiratory fitness training is known to improve $VO2_{max}$ leads to strengthening and enlarging of the heart muscle, to improve its pumping efficiency and reduces the resting heart rate (RHR), known as aerobic conditioning also improves circulation efficiency and reduces BP.[4]

RPP is defined by RHR multiplied by systolic BP (SBP). Under resting conditions, safer RPP should range between 7000 and 9000 mmHg/min. Any total value >10,000 mmHg/min indicates an increased risk for heart disease. At the same time, low RPP value suggests the restricted coronary blood supply with inadequate ventricular function. There are few studies showing improved RPP after regular aerobic training.[5,6]

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However, there are quite a few studies comparing the different intensities of aerobic exercise on cardiovascular system, so the current study was designed to compare the effect of high and low intensities of aerobic exercise on cardiovascular system.

### Objective

The objective of this study was to study the effect of high and low intensities of aerobic training on rate pressure product (RPP).

## MATERIALS AND METHODS

A total of 80 sedentary male aged between 18 and 40 years were recruited from two fitness centers. Subjects were informed about the study and informed written consent was taken. Subjects were allocated into two equal groups of low-intensity and high-intensity exercise regimen using random number table.

### Inclusion Criteria

- Men aged between 18 and 40 years who volunteered to participate in the study.

### Exclusion Criteria

- Involvement in a regular exercise or weight loss program for at least 6 months before the recruitment.
- H/o cardiovascular disorders.
- H/o endocrinologic or orthopedic disorders.

The anthropometric measurements included weight, height, waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-stature ratio (WSR) following the recommendations of the World Health Organization.[7]

RHR: Radial pulse was taken after subject rests for 15 min, felt for full 1 min, and noted down.

BP of each subject was recorded using digital sphygmomanometer (ACCUMAM), which recorded both systolic, diastolic BP, and even heart rate. BP was recorded 3 times with 5 min gap between each recording and average of three readings was displayed and noted.

RPP: Calculated using the formula

Rate pressure product (mmHg/min) = Systolic blood pressure × heart rate

### Exercise Training Protocol

Digital cycle ergometer (COSCO, MODEL-CEB-JK-7007 A) which displays heart rate and level of exercise was used for the aerobic exercise. The aerobic training was designed to exercise the upper and lower body: For high-intensity group – subject exercised at Level 5, at 50 rpm, accounting to 150 watts (900 kpm) for 15 min at 80% HR max (80% $VO2_{max}$) and for low-intensity group – subject exercised at Level 3, at 75 rpm, accounting to 90 watts (540 kpm) for 30 min at 50 % HR max (50% $VO2_{max}$).

Both the groups exercised at different duration so that the work done by both the groups were almost equal. Subjects used to exercise either in evening or morning depending on their convenience. All subjects used to exercise 5 days a week continuously for 12 weeks. At the end of 12 weeks, all the parameters (weight, body mass index [BMI], WC, WHR, RHR, and RPP) were measured again.

## STATISTICAL TESTS

SPSS 16.5 version of the statistical package was used for analysis of the data. Descriptive statistics like mean and standard deviation were calculated. Paired *t*-test of significance was used to study the difference between the baseline and post-interventional values of study variables.

## RESULTS

Majority of our study population (55%) were between 21 and 30 years of age group; very few were below 20 years [Table 1].

Mean BMI, RHR, and RPP decreased in both the groups being more significant ($P < 0.05$) in high-intensity group. Results summarized in Tables 2 and 3.

**Table 1:** Age wise distribution of study population

| Agegroups (in years) | High-intensity Group *n*=40 (%) | Low-intensity Group *n*=40 (%) |
|---|---|---|
| <20 | 3 (7.5) | 5 (12.5) |
| 21–30 | 23 (57.5) | 21 (52.5) |
| 31–40 | 14 (35) | 14 (35) |

**Table 2:** Parameters in high-intensity group

| Parameters | Baseline | After 12 weeks | *t* |
|---|---|---|---|
| BMI (kg/m$^2$) | 26.39±1.17 | 25.6±1.2 | 2.58 |
| RHR (beats/min) | 79.79±7.71 | 74.05±6.10 | 7.33* |
| SBP (mmHg) | 132.25±7.52 | 127.1±6.88 | 4.33 |
| DBP (mmHg) | 76.6±5.94 | 73.8±5.43 | 1.64 |
| RPP (mmHg/min) | 10574.31±1312.21 | 9419.1±1008.63 | 7.68* |

*Statistically significant ($P$<0.05). BMI: Body mass index, RHR: Resting heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, RPP: Rate pressure product

**Table 3:** Parameters in low-intensity group

| Parameters | Baseline | After 12 weeks | *t* |
|---|---|---|---|
| BMI (kg/m$^2$) | 28.57±2.44 | 27.39±2.46 | 6.58* |
| RHR (beats/min) | 79.75±7.74 | 73±6.43 | 7.68 * |
| SBP (mmHg) | 128.15±10.96 | 122.1±7.73 | 4.37 |
| DBP (mmHg) | 76±5.80 | 74.95±5.63 | 1.68 |
| RPP (mmHg/min) | 10344.31±1484.21 | 8930.4±1126.61 | 9.24* |

*Statistically significant ($P$<0.05). BMI: Body mass index, RHR: Resting heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, RPP: Rate pressure product

SBP and DBP decreased in both the groups but not statistically significant.

## DISCUSSION

In our study, RHR and RPP decreased in both intensities of aerobic exercise but more significant in high-intensity group. The results were consistent with Shiotani *et al.* study which showed that aerobic exercise exerts beneficial effects on the circadian rhythm of heart rate, especially in the morning.[8]

Endurance-trained subjects are known to have a significant resting bradycardia. Vigorous-intensity exercise confers greater cardioprotective health benefits than moderate-intensity exercise, including a lower incidence of coronary heart disease that may be related to lower-risk factors. Clinical trials have found that higher intensity exercise resulted in greater reductions in resting BP than lower intensity.[9,10]

According to White WB, RPP of 12,000 or below with the HR of 60–120 bpm and SBP of 100–140 mmHg is considered to be normal without any existing or future risk of cardiovascular complications in normal individuals.[11] All our study participants, RPP was within normal levels.

RPP really illustrates the oxygen demands of the heart for a person who is in a good physical condition like a trained athlete, the oxygen demands of the heart place less contributing stress in a workout, whereas an untrained individual experiences an elevated stress from cardiac demand and the fatigue of respiratory muscles attempting to satisfy this demand. Hence, a trained person with less RHR and less resting BP will have effective myocardial oxygen consumption and ultimately later onset of fatigue when compared to an untrained person.

Lesser RPP is an indicator of more parasympathetic activity and increased parasympathetic tone is believed to be cardioprotective.[12] Hence, our study shows the cardioprotective effects of aerobic training.

Regarding the role of the exercise's intensity on health parameters, despite the increasing interest on high-intensity training, there is still no accordance between researchers. Clinical trials generally reported greater improvements after vigorous (typically > or = 60% aerobic capacity) compared with moderate-intensity exercise for diastolic BP, RHR glucose control, and aerobic capacity, but reported no intensity effect on improvements in SBP, lipid profile, or body fat loss.[13]

Many studies show that high-intensity aerobic training improves aerobic capacity ($VO2_{max}$) and physical fitness index in comparison with low-intensity training.[14,15,16]

## CONCLUSION

Even though regular aerobic training offers cardioprotection, high-intensity method of training seems to be more beneficial when compared to the low-intensity method.

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