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EXERCISE HEART RATE DURING A STEPWISE CYCLING TEST BEFORE AND AFTER AEROBIC TRAINING PROGRAM

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ABSTRACT
The objective of present study was to the effect of aerobic training program on exercise heart rate during a stepwise cycling test in sedentary adult obese men. For this purpose, a stepwise cycling test was performed before and after three months aerobic training in twelve sedentary adult obese men as exercise or control (no training) groups. Resting heart rate and exercise heart rate of each stage of stepwise cycling and cardiorespiratory fitness were measured at 2 mentioned occasions. Data was compared by independent-paired T test. No significant differences were observed in all variables between two groups at baseline (ore-test). Aerobic training program resulted in significant decrease in resting heart rate ($p = 0.012$) and significant increase in VO2max ($p = 0.005$) in exercise group. We observed that the heart rate of each stage during cycling test decreased significantly when compared with pre training in exercise subjects ($p < 0.05$). Our findings indicate that a prolonged aerobic program can be improved exercise heart rate and cardiorespiratory fitness in adult obese men.

KEYWORDS: Aerobic capacity, Exercise, Heart rate, Obesity,

INTRODUCTION

Success in sports certainly relies on the right training program design tailored to the training objectives. Exercise intensity prescription or provision for training programs involves determining the correct intensity level based on the effective factors. Heart rate measurements are conducted assuming its linear relationship with the oxygen consumption and is used for recording and controlling the exercise intensity (Swain et al., 1977; Karvonen, 1957; Wen et al., 2007). However, some researchers have pointed out to the nonlinear relationship between VO2 and HR. They have also noted the dependence of their curve slope and curvature to the fitness levels (Beck et al., 2006; Vella et al., 2005). Heart rate is one of the easiest and most accessible variables for understanding cardiovascular performance. In fact, heart rate reflects the amount of activity heart has to perform in response to demand of oxygen or other nutrients of body tissues at rest, or especially muscle activity during exercise (Wilmore, 1994). Increased age is associated with a lower resting heart rate. The literature suggests that the best time to test resting heart rate is in the morning before getting up from bed (Wilmore, 1994). During exercise, the heart rate increases proportionate to the exercise intensity. Heart rate increases linearly by the increased workload or oxygen demand of body tissues. Increased heart rate during exercise occurs in response to hormonal and neurological effects induced by the body's needs to provide energy (Edward, 1989). However, most researchers point out to the maximal oxygen consumption as the most prominent indicator of cardiopulmonary fitness (Wen et al., 2007). Although the literature supports the resting heart rate and VO2max as the important measures of cardiorespiratory fitness, it seems that the pattern of changes in heart rate during exercises at different intensities leads to more important outcomes regarding cardiovascular condition and physical fitness. This study aimed at investigating the effect of aerobic training on resting and exercise heart rates and VO2max and measuring the pattern of heart rate changes at different stages of an exercise test before and after training.

MATERIALS AND METHODS

Subject included twenty four sedentary healthy adult obese men aged 28-40 years and body mass index 170-180 kg/m2 that participated in this study by accessible samples and divided randomly in exercise (3 months aerobic training, 3 time/weekly) or control (no training). The study protocol was approved by the Research Ethics Committee of Islamic Azad University, Saveh Branch. Written consent was obtained from each subject after the experimental procedures and possible risks and benefits were clearly explained. Obesity was determined by BMI. Participants were included if they had not been involved in regular physical activity in the previous 6 months. Subjects with a history or clinical evidence of impaired fasting glucose or diabetes, recent myocardial infarction, active liver or kidney disease, the other chronic were excluded.

Anthropometrical measurements

Weight and height were measured in the morning, in fasting condition, standing, wearing light clothing and no shoes. BMI was calculated by dividing body mass (kg) by height in meters squared (m2). Waist circumference was measured after a normal expiration under the midline of the subject's armpit, at the midpoint between the lower part of the last rib and the top of the hip. Hip circumference was measured at the level of the greater trochanter, all parameters being measured by well-trained dietitians.

Cardiorespiratory Fitness and training protocol

Measurement of VO2max, VO2max was determined during stepwise cycling test. Cycling test included 4 continues stage without rest between stages and each stage lasted 3 minute (Mullis et al., 1999). The test was an ergometry test consisting of 4 three-minute consecutive stages without a break. The workload was increased from each stage to the other. Before the exercise, the ergometry cycle seat was adjusted to suit the subjects' height so that when the pedal was at the lowest point, the knee of the subject was in 5-10 degrees flexion. The subject was then asked to cycle for one minute without pedal resistance. The subject was also instructed to cycle with a constant speed of 50 rpm (revolutions per minute). The workload was 50 watts at the first stage which was increased by 25 watts in each three minutes. During the tests, all subjects were verbally encouraged to continue. Heart rates were monitored and recorded at all steps. In the final 10 seconds of each stage, the heart beat was recorded by a polar heart beat recorder mounted around the subject's waist. Subject in exercise group were completed an aerobic exercise program lasted three months and control subject did not participate in exercise program in this period. Each exercise session was supervised by an exercise physiologist or one of the study physicians. In each session, subjects completed a 5-10 min warm-up, followed by 60 min of aerobic exercise at 60-80%VO2max (with continuous heart rate monitoring) and a 5-min cool down. The exercise intensity was controlled using the Polar heart rate tester (made in the US).

Statistical analysis:

After calculation of the mean and the standard deviation, the statistical analysis was conducted using the SPSS software version 15.0. Kolmogorov-Smirnov test was used to determine of normal status of the data. Independent student t test was used for between groups comparison at baseline. Student's paired 't' test was applied to compare the pre and post training values. Pearson's correlation coefficient was run for testing of correlation analysis. The results were considered statistically significant for $p<0.05$.

RESULTS

In present study, the change pattern of heart rate during a stepwise cycling test was compared between before and after a three months aerobic training. Table 1 show the descriptive anthropometric and biochemical features of the study groups. There were no differences in all independents variables between two groups at baseline ($p > 0.05$). Aerobic program resulted in significant decrease in all anthropometrical markers of exercise group ($p < 0.05$) but these variables remained unchanged in control subjects ($p > 0.05$). Resting heart rate decreased significantly by aerobic training in exercise group when compared with pretest ($p = 0.012$). A significant increase was also found in cardiorespiratory fitness in exercise group by aerobic training program ($p = 0.005$, Fig 1). Based on data of student T test, we observed that the heart rate of each stage during cycling test decreased significantly when compared with pre training in exercise subjects ($p < 0.05$). All variables remained unchanged in control subjects ($p > 0.05$).

Table 1: Mean and SD of anthropometrical markers and physiological future of study groups

variables	Exercise group		Control group	
	Pre-training	post-training	Pre-training	post-training
Age (year)	29 ± 7.14	29 ± 7.14	30 ± 6.14	30 ± 6.14
Height (cm)	176 ± 8.21	176 ± 8.21	175 ± 7.56	175 ± 7.56
Weight (kg)	102 ± 11.4	95 ± 12.8	101 ± 9.9	100 ± 8.5
Abdominal circumference (cm)	108 ± 8.2	103 ± 9.4	107 ± 7.21	107 ± 8.7
Hip circumference (cm)	105 ± 9.2	101 ± 8.1	104 ± 8.6	103 ± 7.3
AHO (Ratio)	1.03 ± 0.32	1.02 ± 0.24	1.02 ± 0.28	1.04 ± 0.54
BMI (kg/m2)	32.9 ± 3.4	30.2 ± 4.1	33 ± 3.1	32.7 ± 3.4
Resting heart rate (bpm)	78 ± 6	67 ± 9	76 ± 7	78 ± 9
VO2max (ml/kg/min)	25.1 ± 5.3	32.4 ± 6.3	24.1 ± 4.5	24.8 ± 5.1

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Fig 1: Pre and post training of VO2max of two groups

Table 2: Heart rate of each stage of exercise test of two groups				
Exercise stage	Exercise group Pre-training	post-training	Control group Pre-training	post-training
Stage 1	96 ± 7	86 ± 9	98 ± 9	**96 ± 10**
Stage 2	119 ± 11	108 ± 12	121 ± 12	**123 ± 13**
Stage 3	130 ± 14	119 ± 13	132 ± 13	**133 ± 14**
Stage 6	**143 ± 21**	**134 ± 19**	**145 ± 19**	**143 ± 21**

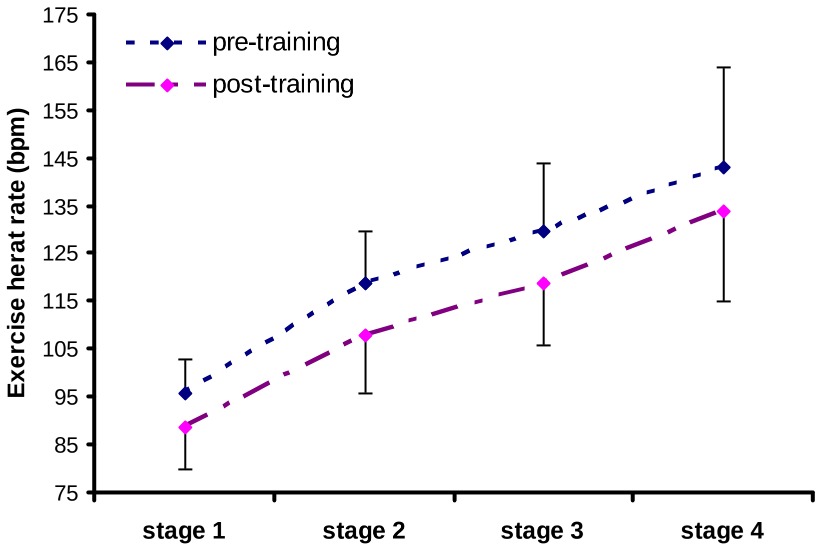

Fig 2: The change pattern of heart rate in exercise stages in pre and post-training of exercise group.

DISCUSSION

Resting heart rate can decrease significantly following training in a previously sedentary individual (Jothi et al., 2011). Three months of aerobic exercise significantly decreased the resting heart rate in the obese men who had previously had a sedentary lifestyle. The training program also reduced the exercise heart rate during cycling test compared to before the training program. These findings support the beneficial effects of aerobic training on the cardiovascular condition of obese men. Increased heart rate during exercise is seen especially when maintaining or increasing cardiac output is slowed by the increased stroke volume. In this case, an increased cardiac output is in response to the increased heart rate (Edward, 1989). The response of cardiovascular system to exercise increases the volume, walls and chambers of the heart. Similar to the skeletal muscles, myocardium undergoes hypertrophy in response to prolonged exercise, particularly endurance trainings. Cardiac hypertrophy is an adaptation to exercise, particularly endurance trainings (Wen et al., 2007).

Exercise decreases the resting heart rate and heart rate during exercise as the trained subjects have lower resting and exercise heart rates compared to their non-athlete counterparts. When exercising at any level of intensity, the trained subjects have a lower heart rate than the untrained subjects. In fact, in response to a given exercise, lower heart rate along with high stroke volume is of the characteristics of the higher circulatory system performance. This phenomenon has been observed in response to prolonged exercise (Edward, 1989). Reduced resting and exercise heart rate can be attributed to the reduced weight and body mass index in the studied population because the training program decreased the weight, waist circumference, body fat percentage, and BMI.

VO2max, or the maximal oxygen consumption, is the maximum amount of oxygen that is consumed during maximal exercise and is an important indicator in the estimation of cardiovascular fitness (Shephard et al., 1968). VO2max is measured by clinics and health care centers to diagnose chronic heart and lung diseases (Vella et al., 2005; Gormley et al., 2008). The findings of this study showed that VO2max levels were significantly increased in response to exercise. In other words, a three-month aerobic training significantly increased the cardiorespiratory fitness in the studied obese men. In adults, VO2max reached its highest after 8-18 months of aerobic training. After that, although VO2max did not increase further, the cardiovascular performance was still increasing. The researchers believe that this cardiovascular performance in the absence of an increase in VO2max is due to the increased lactate threshold or the increase in the subject's tolerance to lactate accumulation (Wilmore, 1994).

The response of the cardiovascular system to exercise appears in the form of changes in the heart rate and is consistent with the body's response to the oxygen demand. This means that when the workload increases during physical activity or exercise, the body needs more oxygen. During exercise, maximum heart rate and maximal oxygen consumption are typically achieved at the same time, so that the maximal oxygen consumption can be approximately estimated from the heart rate variations based on the relationship between the changes in tissues' oxygen consumption and increased workload and the relationship between the heart rate variations and the increased workload (Mezzani et al., 2007; Wilmore, 2005). If at any point of the exercise, a person's heart rate or oxygen consumption is lower, this situation reflects his/her higher physical condition than other subjects (Wen et al., 2007). The findings of this study showed after the training program, the heart rate was significantly lower than before the training program in each of the four stages of the exercise test.

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