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Aerobic Training Program does not affect the Relationship between % VO_2max and % HRR in Obese Individuals

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ABSTRACT: Exercise intensity is an important parameter for exercise prescription. The objective of present study was to compare the relationship of %VO2max with %HRR in adult obese men between before and after exercise training program. For this purpose, cardiorespiratory fitness (VO_2max) was measured before and after three month aerobic training. The relation of %VO_2max and % HRR was compared between pre and post training. Statistical analysis used by paired T-test and Pearson's correlation coefficients. Aerobic program resulted in significant increase in VO_2max in studied subjects ($p < 0.01$). A significant correlation was found between %VO_2max with %HRR either before or after aerobic training program. Aerobic program did not affect the relationship between %VO_2max and % HRR when compared with pre test. in conclusion, despite improved cardiorespiratory fitness, the relation between %VO_2max and % HRR as two exercise intensity index does not affect by aerobic training intervention in obese subjects.

Keywords: Exercise intensity, Aerobic training, Cardiorespiratory fitness

INTRODUCTION

Heart rate is measured assuming its linear relationship with oxygen consumption. This phenomenon is used for recording and controlling the intensity of the exercise [1-3]. Therefore, the American College of Sports Medicine (ACSM) considered the percentage of heart rate reserve (%HRR) and %VO_2max equivalent in the prediction of the exercise intensity. This has been supported by some researchers in the area of sport sciences. In addition, the balance between these two indices of workout intensity is gradually being supported in the majority of scientific studies, and even in rehabilitation programs, aiming for the improvement of cardiorespiratory fitness of patients. For example, findings' of Van's study on the patients with chronic obstructive pulmonary disease, who had relatively low fitness, suggest almost similar values of % HRR and %VO_2max [4]. Yet, Swain et al. have put that %HRR and %VO_2max are equivalent in prescribing exercise intensity in people with lower physical fitness. In addition, compared to other methods, VO_2R% provides people, especially those with low physical fitness, with more accurate exercise load. On the other hand, a study by Vala *et al.* suggests a significant non-linear relationship between cardiovascular variables (cardiac output, stroke volume, and heart rate) and VO_2 in endurance athletes with average physical fitness [5]. These factors per se affect equivalence pattern of the exercise intensity indicators, in that some studies indicate inconsistency of these indicators [6-10]. However, some studies report a closer relationship of these indices in the people with high physical fitness. In this regard, Tollfree *et al.* reported a significant linear relationship ($R = 0.99$) between VO_2-HR in elite athletes [11].

In addition, the initial investigations on the elderly who performed 6 months of aerobic exercises, leading to 18% increase in VO_2max, showed a more closer correlation between %HRR and % VO_2max [12]. A study by Jakicic also supports this theory [13]. Findings of Sterett et al. suggest that after the adjustment for age and physical fitness, heart rate is an accurate predictor for the assessment of oxygen consumption (VO_2), which leads to increased overlap between exercise intensity indices [14]. These factors per se highlight the effect of physical fitness on the relationship between the indices of exercise intensity [1]. Yet, there are limited studies conducted to determine the effect of long-term workout programs, associated with VO_2max increase, on the correlation between these workout indices. Therefore, the goal of this study is to determine the effect of an aerobic exercise course on VO_2max level as a predictor of cardiorespiratory fitness, as well as its impact on the relationship between % VO_2max and %HRR in non-athlete obese men.

METHOD AND SUBJECTS

Thirty four non-trained healthy obese men (aged 29 ± 7.14 years, body weight 102 ± 11 kg) were enrolled to participate in this study by accessible samples. The study protocol was approved by the Research Ethics Committee of Islamic Azad University, Saveh Branch. After the nature of the study was explained in detail, informed consent was obtained from all participants. Subjects were non-smoker and non-trained. 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.

A. Anthropometry

Anthropometric measurements (body height and weight, abdominal and hip circumference) were performed with the subjects wearing light underwear and without shoes in the morning following a 10-h fast. The Body Mass index (BMI) was calculated using the formula body weight/height^2 in terms of kg/m^2. Waist and hip circumferences were measured at the level of umbilicus and of trochanter major, respectively. Waist to hip circumference ratio was measured by dividing the abdominal circumference into that of the hip.

B. Cardiorespiratory Fitness and exercise program

Before and after the 3-months intervention periods, all subjects performed a stepwise bicycle test on a bicycle ergometer for measure VO_2max. Cycling test included 4 continues stage without rest between stages and each stage lasted 3 minute. In each stage, intensity was increased according to protocol guideline (Mullis *et al.*, 1999). %VO2max and % HRR were calculated by two following formula:

$$\%VO_2\max = \frac{VO2exercise}{VO2\max}$$

$$\%HRR = \frac{H\,\mathrm{Re}\,xercise - HRrest}{HR\max - HRrest}$$

The exercise training intervention was designed to improve cardiopulmonary fitness. The exercise group trained three times per week for 12 weeks included running or cycling at a exercise intensity between 60 - 80 (%) of maximal heart rate. Exercise duration began at 15 min for weeks 1–3, and then systematically increased by 5 min every 3 weeks thereafter to 30 min for weeks 9-12. Warm-up and cool-down periods were performed for 5 minute in each session. Exercise physiologists supervised the exercise sessions, and monitored heart rate.

C. Statistical Analysis

The statistical analysis was run using the Statistical Package for the Social Sciences (SPSS, version 15.0). Kolmogorov-Smirnov test was used to determine of normal status of the data. Student's paired 't' test was applied to compare the pre and post training of anthropometrical markers and VO_2max. Pearson's correlation coefficient was used to determine the correlation between % VO_2max and % HRR in obese subjects.

RESULTS

In present study, we compared the relationship of %VO2max with %HRR in adult obese men between before and after exercise training program.

Baseline (pre-training) and post training VO_2max. levels and anthropometrical indexes of studied subjects are shown in Table 1. Participant characteristics are reported as means ± SD.

All anthropometrical markers decreased significantly by aerobic intervention in exercise group ($p < 0.05$) (Table 1). Exercise training program resulted in a significant increase in VO^2max. when compared with baseline ($p < 0.01$, Fig. 1).

Based on Pearson's correlation coefficients, a significant correlation was found between % VO_2max. with % HRR either before (Fig. 2) or after (Fig. 3) aerobic training program. But the relation between them didn't affect between pre and post training ($p > 0.05$).

Table 1: Pre and Post-training of physical index and VO_2max. of studied subjects.

Variables	Pre training	post-training
Age (year)	**29** (7.14)	-----
Height (cm)	**176** (8.21)	-----
Weight (kg)	**102** (11.4)	**95** (12.8)
Waist circumference (cm)	**108** (8.16)	**103** (9.44)
Hip circumference (cm)	**105** (9.18)	**101** (8.12)
BMI (kg/m2)	**32.88** (3.44)	**30.21** (4.12)
VO2max (ml/kg/min)	**2.55** (0.65)	**3.08** (0.53)

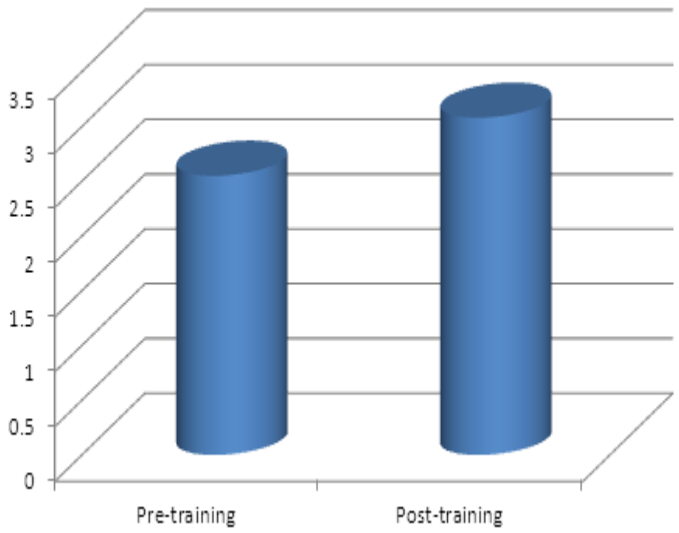

Fig. 1. Pre and post training of cardiorespiratory fitness in studied subjects**.**

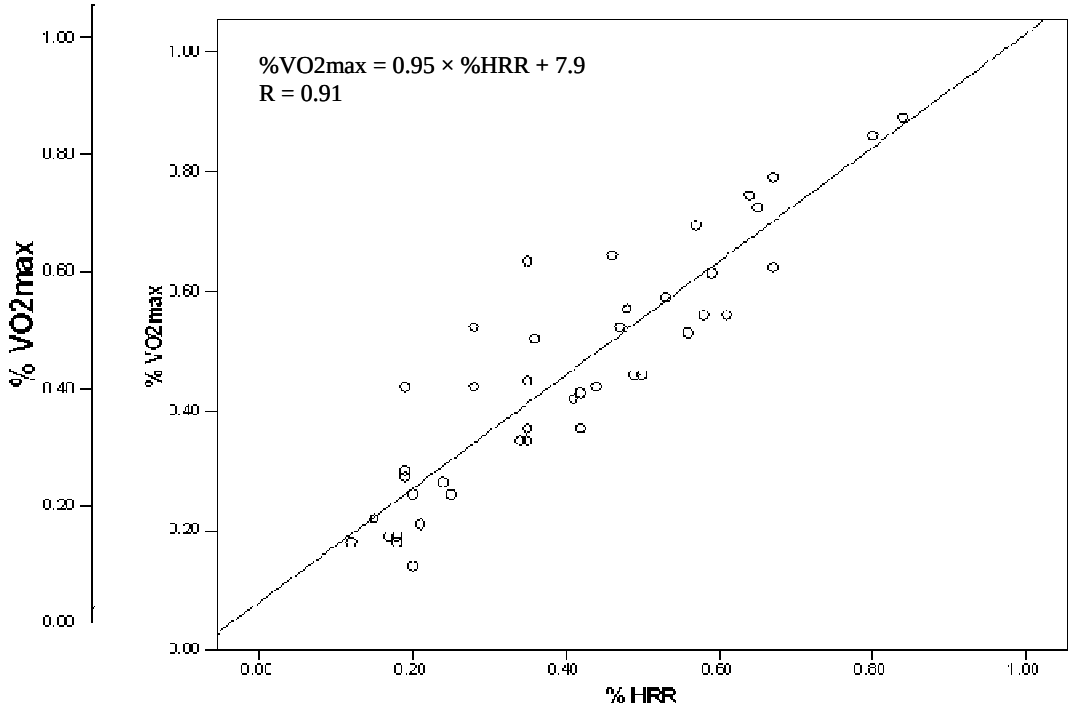

Fig 2: Relationship of %VO2max and %HRR before training intervention.

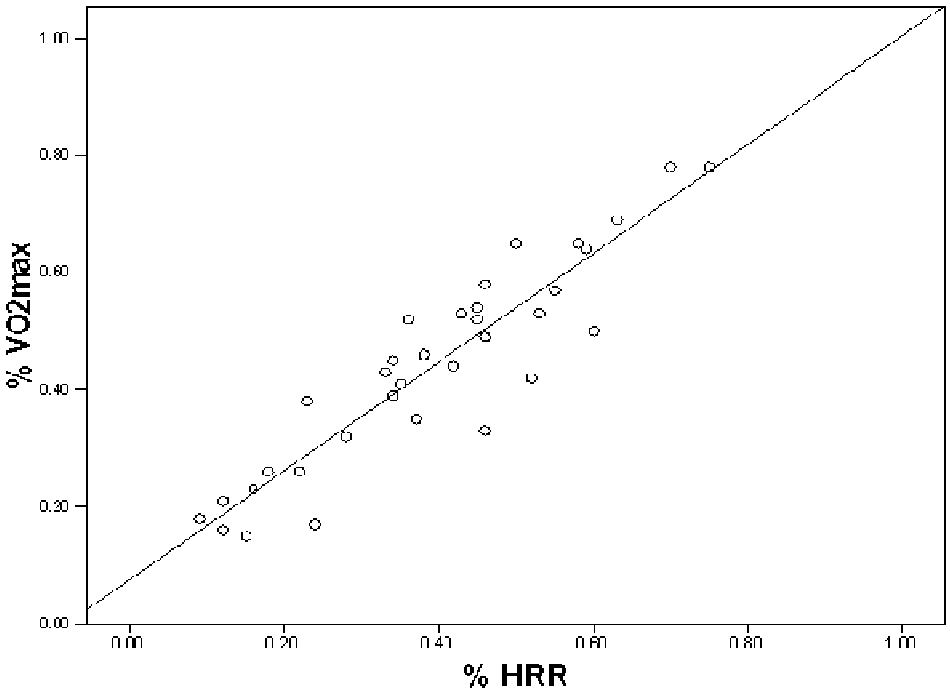

Fig. 3. Relationship of %VO_2max and %HRR after training intervention**.**

DISCUSSION

Although CSM has considered % HRR equivalent to VO_2max for the determination of exercise intensity [6], Simons' findings contradict it in patients with chronic obstructive pulmonary disease [16]. Some researchers as Swain et al. also have put that during cycle ergometer exercise, relative values of % HRR and VO_2max are not equivalent [17]. Findings of similar studies are also heterogeneous and reciprocal [17-19]. In line with the mentioned studies, although the present research supports the statistical findings that maintain a significant, linear relationship between % VO_2max and % HRR during cycling, it indicates increased heart rate during training in parallel with increased oxygen consumption. However, findings show that despite a significant linear relationship between them, the linear pattern of these variables and fit line are not match. In that, at every level of activity, values of % VO_2max based exercise intensity are equal to the numerical values higher than % HRmax.

To prescribe exercise intensity to healthy people, %HRR is widely used, and in the majority of cases it is employed as the determinative factor of metabolic rate [20]. Since in the majority of no-laboratory cases, oxygen consumption (VO_2) cannot be measured, heart rate measurements or % HRR method can be used for determining exercise intensity, assuming a linear relationship between the heart rate and oxygen consumption. However, in most of laboratory tests, the metabolic rate is determined by measuring oxygen consumption [6, 21]. Another method is the prescription of exercise intensity of % VO_2max index [6].

In adjusting %HRR and % VO_2max values, numbers of factors, namely age, physical fitness, maximum or minimum exercise intensity, cardiovascular condition, and environmental temperature are influential [7, 8]. Research findings on the relationship between the indices of exercise intensity in different people vary based on the maturity level, maximum or minimum exercise intensity, cardiovascular condition, disease type, and especially physical fitness [10]. Reviewing research findings suggests that the majority of the mentioned studies have investigated and compared only the relationship between the given indices in a specific group of people, or only have sought the effect of physical fitness on the relationship of these indices in a specific group of athlete, non-athlete, or patients;

in addition, there are limited numbers of studies that have investigated the mentioned objectives in a specific group of people whose physical fitness has been improved through exercise trainings within a certain time interval. Literature put that the lower is one's cardiovascular or initial fitness, the greater is difference of these indices of exercise intensity; in that, improved cardiovascular fitness decreases the difference of those indices at every level or intensity of physical activity [12, 13].

In this regard, some studies support a non-linear relationship between the cardiovascular variables and oxygen consumption rate in people with lower endurance fitness [5]. Moreover, a closer relationship between the indices of exercise intensity has been observed in athletes relative to non-athletes in some other studies [11]. In the present study too, three months of aerobic exercise significantly increased VO_2max, as the determination index of cardiovascular fitness, in the investigated obese men. Thus, according to the mentioned evidence, it is expected that increased value of VO_2max makes the relationship pattern of %HRR and % VO_2max more similar. Despite what have been said, the findings of this study did not show any significant difference in the relationship between these exercise intensity indices from the pre- and post-test results. In fact, these findings indicate that although the three-month aerobic exercise program used in this study has significantly improved VO2max and resting and target exercise heart rates in the investigated obese people, this program did not cause any significant change in the relationship between exercise intensity indices in pre- and post-program conditions. Therefore, it seems that the effect of improved cardiovascular fitness on the relationship between the indices of exercise intensity is more related to the type of disease in the patient rather than healthy people.

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