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EFFECT OF MODERATE AND HIGH INTENSITY AEROBIC EXERCISE ON THE BODY COMPOSITION OF OVERWEIGHT MEN

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ABSTRACT

Marra C, Bottaro M, Oliveira RJ, Novaes JS. Effect Of Moderate And High Intensity Aerobic Exercise On The Body Composition Of Overweight Men. ***JEPonline*** 2005;8(2):39-45. The optimal aerobic exercise training intensity to improve body composition in overweight men is unclear. The purpose of this study was to determine the effect of 14 weeks of high intensity versus moderate intensity aerobic exercise of equal work output on body composition in overweight men (BMI = 25-29.9 kg/m^2). Sixteen sedentary military men (18 - 33 yrs) were randomized in two equal groups (n=8): 1) moderate intensity exercise (MI; 60 - 70% of their maximum heart rate; HRmax), and 2) high intensity exercise (HI; 75 - 90% HRmax). The aerobic exercise (jogging/running) training program was performed three days/wk. Relative body fat (% BF) was assessed by dual energy x-ray absorptiometry (DXA) (Lunar DPX - IQ). Significant differences between and within the groups were analyzed using a two-way split-plot analysis of variance (SPANOVA). Statistical significance was accepted at $p<0.05$. After the 14 wks of the aerobic exercise program the mean %BF of the HI significantly ($p<0.05$) decreased to 22.49 % (Δ=4.91%). The decrease in mean %BF (Δ=1.4 %) in the MI was not significant ($p>0.05$). It is concluded that 14 wks of HI aerobic exercise may be more effective in improving body composition than MI aerobic exercise in overweight young military men with physical characteristics similar to the present study.

Key Words: Obesity, DXA, Fat mass, Aerobic training

INTRODUCTION

At first glance, it would seem that concern with body composition is reserved primarily to athletes, since athletic performance is partially influenced by the proportion of fat free mass and fat mass (1). However, body composition is an important aspect of health for individuals from all age, gender, and ethnic groups. For example, obesity is a significant public health problem in the United States and other developed countries (2). According to the American College of Sport Medicine (3), obesity has been shown to be associated with chronic diseases and health conditions such as cardiovascular disease, hypertension, diabetes, specific types of cancer and other chronic diseases.
It is well established that aerobic exercise can be an important component of weight loss intervention (3), and therefore is commonly included as part of a comprehensive weight management program. However, there is a controversy over whether exercise duration or exercise intensity is more important for stimulating decreases in the body fat content.

Girandola et al. (4), and Swenson & Conlee (5) reported that percent fat decreases more from low intensity (LI) than high intensity (HI) aerobic exercise. However, other studies have reported no differences on %BF between LI and HI aerobic exercise in overweight sedentary women (6,7,8). Van Aggel-Leijssen et al. (9) also reported no %BF differences between LI (40% VO_2max) and HI (70% VO_2max) exercise after 12 weeks in obese men. Nevertheless, Bryner et al. (10), Lennon et al. (11) and Tremblay et al. (12) reported that relative body fat decreases more in young overweight women at HI aerobic exercise than LI.

Unfortunately, because of conflicting studies the impact of aerobic exercise intensity on body fat stores in overweight men is still unclear. Thus, the purpose of this study was to determine the effect of HI and moderate intensity (MI) aerobic exercise, of equal work output, on body composition in overweight young men.

METHODS

Subjects

Sixteen overweight military men aged 18 to 33 years with a BMI between 25.0 to 29.9 kg/m^2 were recruited from a military base in Brazil to participate in a 14-week aerobic exercise study. The criteria for participation in the study were no involvement in a regular exercise or weight loss program for at least 6 months prior to the first visit and no known cardiovascular, endocrinologic or orthopedic disorders. After written informed consent was obtained, all potential subjects underwent a complete medical examination to determine their ability to participate. Eligible subjects were randomly assigned to one of two groups: 1) moderate intensity exercise (MI; 60 - 70% of their maximum heart rate-HRmax), and 2) high intensity exercise (HI; 75 - 90% HRmax). Subjects were requested to maintain their dietary habits during the study. To better control internal validity all the subjects slept and had their meals inside the military base. The study protocol was approved by the Catholic University of Brasilia ethics committee.

Exercise Training Protocol

The exercise training program consisted of jogging or running a distance of 3 km during the first 5 weeks and 4 km during the last 9 weeks at either moderate intensity exercise (MI; 60 - 70% of their maximum heart rate, HRmax) or high intensity exercise (HI; 75 - 90% HRmax). Eight subjects participated in the MI and eight subjects in the HI training program. Subjects trained 3 times/week for 14 weeks. Training duration for subjects in the MI and HI training program was 38.1±2.7 and 23.0±3.7 min, respectively. Heart rate was monitored continuously during the training sessions (Polar Electro, Oy, Finland). All training sessions took place at the Integrated Center of Electronic War tracking (Brazilian Army Base) under the supervision of a professional instructor.

Anthropomety

Subjects were weighed on a digital scale accurate to 0.1 kg (Filizola digital®, model personal line, São Paulo, SP, Brazil). Height was measured to the nearest 0.1 cm by using a wall-mounted stadiometer (Country Technology™, model 67031, Gays Mills, WI, USA).

Body Composition

Dual Energy X-ray Absorptiometry (DXA) assessed changes in body composition. According to Houtkooper et al. (13), DXA is the most sensitive method for assessing small changes in body composition over a period of time. The DXA used as the criterion measure in the present investigation was a Lunar® DPX-IQ (software 4.6A). The instrument works on the physics principle that, as x-rays pass through the body, the exiting attenuated signal is exponentially related to the path length, tissue density, and energy of the X-ray. The x-ray source, mounted beneath the patient, generates a narrow, tightly collimated beam of X-rays that pass through the patient at rapidly switched energies of 70 and 140 kVp. Participants lie supine on the scanning bed and are scanned from head to toe in ~20 min.

As the x-ray beam is introduced into the body, the external detector analyzes one small cross-sectional area, or pixel (1 × 1 mm area), at a time. For the analysis, each pixel in the image is determined to be one of two components: bone or soft tissue. Spatial threshold is the outline around bone and determines the mass of the bone and tissue in adjacent areas. DXA divides the body into three components: total body bone mineral, or ash; fat-free, mineral-free soft tissue; and fat. By using the appropriate beam ratio and/or attenuation values obtained from phantom tissue samples, the fat mass (FM) and fat free mass (FFM) can be established from the measured values.

Maximum Oxygen Consumption (VO_2max)

Peak oxygen consumption (PVO_2) was determine at baseline and at 14 weeks by a treadmill graded exercise test (GXT). Participants received a verbal overview of the GXT procedure before the test. During the experiment, ventilatory and gas exchange responses were measured continuously by using indirect calorimetry (Aerosport metabolic system, VO_{2000}). The highest oxygen uptake achieved over 30 s was taken as VO_2max. An electrocardiogram recorded heart rate continuously.

Statistics

Descriptive statistics, Student's *t* test, and analysis of variance (ANOVA) with a two-way split-plot (between factor = MI/HI; within factor = PRE/POST training) were performed using the Statistical Package for the Social Science (SPSS 8.0, Chicago, IL, USA). Student's *t* tests for independent sample were used to analyze differences between groups at baseline, and a two-way (group x time) analysis of variance was used to examine the changes between MI and HI groups. Further comparison were made using Student's paired-sample *t* test (MI or HI) to assess the significance on relative body fat between pre- and post-testing. All tests were two tailed, and an *alpha* level of $p<0.05$ was regarded as statistically significant. Data are expressed as means (M)±standard deviation (SD).

RESULTS

Subject physical characteristics can be found in Table 1. Although the extensive commitment required of each participant, all individuals completed the entire study (n=16) and were included in the final analyses. Mean age, height, weight, and relative body fat did not differ between MI and HI groups. Maximum oxygen consumption (VO_2max) at the started of the study was significantly higher ($p<0.05$) in HI

Table1. Subject characteristics (Mean±SD)

Variable	*Moderate Intensity (n = 8)*	*High Intensity (n = 8)*
Age	24.86±4.94	26.25±5.59
Height (cm)	172.60±6.14	171.00±6.74
Weight (kg)	82.63±9.10	82.25±8.51
Body mass index (kg/m^2)	27.74±2.2	28.13±2.8
% Body fat (DXA)	27.09±2.80	27.40±7.09
VO_2max (ml/kg/min)*	46.86±3.24	51.44±3.80*

* Significant ($p<0.05$) between-group difference determined by Student's
independent *t* test

compared with MI.

SPANOVA statistical test comparison of means showed that there were no significant differences between groups for change in percent body fat. However, *post-hoc* test showed that there was a significant decrease ($p < .05$) in the relative body fat in HI during the course of the study (Δ=4.91 %BF). There was no significant change ($p > .05$) across the study in the percentage of body fat (Δ=1.43) for MI (Figure 1).

DISCUSSION

The purpose of this paper was to discuss the results of a prospective study in which two groups of young overweight men exercised at different intensities while performing the same amount of work. The results showed that only subjects in HI had a significant decrease in their percent body fat. The difference in fitness level at the start of the study between groups allowed them to exercise not only the same amount of time per day but also the same distance even though the intensity of the exercise was significantly different.

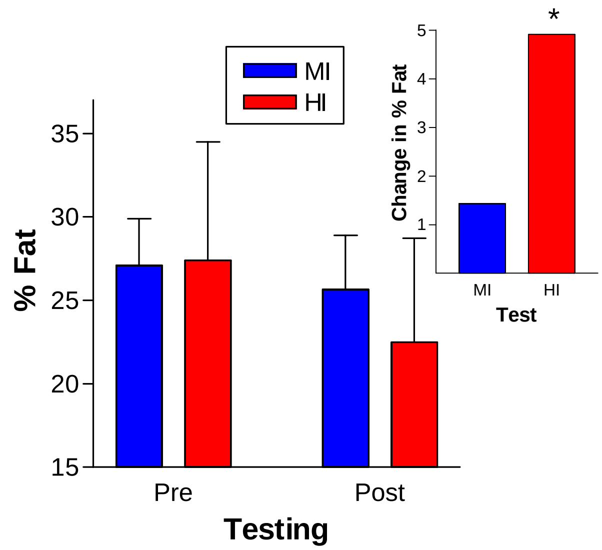

Figure 1. Relative Body composition changes by treatment. * Indicates significant difference within group. MI = Moderate intensity exercise group; HI

Exercise training has long been thought be a good addition to any weight loss program because individuals who train on regular basis are usually thin and of lower fat compared with their sedentary counterparts. Tremblay *et al*. (14) conducted a cross-sectional study to compare the effects of physical activity intensity on body composition. The investigation involved 1,366 women and 1,257 men aged 20 to 49, all participants in the 1981 Canadian Fitness Survey. In order to determine the intensity effects on body adiposity, subjects were assigned by sex to four subgroups: 1) those who reported they did not engage in any leisure activities (5 to 6 METS); 2) those who reported they engaged in leisure activities of 5 to 7 METS; 3) those who reported they engaged in leisure activities of 7 to 9 METS; and 4) subjects who reported they engaged in leisure activities exceeding 9 METS. As a result, subjects from group four had a smaller abdominal circumference, with a significant difference from groups one, two, and three for both men and women. As the authors suggested, the most important finding in this study was that people engaging in vigorous activities had less subcutaneous fat. A significant difference persisted among groups even when statistical control was introduced in order to remove the caloric expenditure resulting from activities. The persistence of this significance indicated that both the effects of exercise on body fat and its distribution result from energy balance components, such as increased post-exercise resting metabolic rate, rather than from the energetic cost of activities.

There are only a few studies comparing the effects of both high- and low-intensity aerobic exercise on body composition, and their results show that percent fat reduction under high-intensity exercise is often null (15). Bryner *et al*. (10) ran a 15-week investigation with subjects engaging in exercise four times a week. The study was designed to compare continuous running aerobic exercise at low intensity (heart rate around 132 beats/min) and high intensity (heart rate around 163 beats/min), with sessions during approximately 40 to 45 minutes for both groups. Dietary control was conducted by writing down each individual's intake for a whole week. Bryner's study included 15 women aged 18 to

34, randomly divided into two groups: low intensity (n=7) and high intensity (n=8). The authors found that under the high intensity aerobic exercise the percent body fat dropped from 27 ± 7.0 to 22 ± 4.0 % ($p<0.05$), while in the low-intensity group the reduction of 22 ± 6 to 21 ± 6 % was not significant ($p>0.05$). The authors concluded that the high-intensity physical exercise resulted in a significant percent fat reduction even with no caloric restriction.

Results obtained by Bryner *et al.* (10) were similar to those in this study, in which the group engaging in the high intensity physical exercise (75 at 90% HRmax) had a significant percent fat reduction, while that performing the moderate-intensity physical exercise (60 at 70% HRmax) had no significant loss.

In an investigation by Grediagin *et al.* (7) with a trial design quite similar to that in this study, twelve over-fat, sedentary women were randomly assigned to 1) a high-intensity (80% VO_2max) or 2) a low-intensity (50% VO_2max) exercise group. Subjects trained 4 times/week for 12 weeks. During this time subjects were instructed to maintain their normal diet and activity patterns. Body composition was analyzed using hydrostatic weighing. Post-testing showed no significant inter-group difference regarding body weight, percent body fat, fat mass, and fat-free mass. Mean weight loss was 0.32 kg for the high-intensity group and 1.50 kg for the low-intensity group. The HI group had a 1.95 kg increase in fat-free mass, whereas this increase was only 0.82 kg in the LI group, which may explain this inter-group difference in weight loss. For percent body fat, a reduction of 3.4±4.1 % was found in the HI group, and a 2.9±3.9 % in the LI group, both being statistically significant ($P< 0.05$).

The discrepancy in the results of the study by Grediagin *et al*. (7) and those hereof may be due to the fact that body composition was measured using hydrostatic weighing in overweight women, a method currently considered to be less ideal than Dual Energy X-ray Absorptiometry (DXA) for obese population. Another difference worth mentioning is that food intake was more closely controlled in both this study and that by Bryner *et al.* (10). Since sample individuals in this study ate their main meals within the military base, they followed the researcher's instructions closely.

In a 12-week investigation, Swenson & Conlee (5) had subjects engaged in exercise 5 times/week to evaluate body composition differences between a group performing low-intensity aerobic exercise (540 kpm/min) and another one performing high-intensity aerobic exercise (900 kpm/min), using a cycle ergometer. The sample consisted of 15 adult men. Diet of subjects was not controlled. Both groups exercised 45 minutes/day. Statistical analyses indicated that both groups experienced a significant fat reduction, although more fat was reduced in the low intensity group. There was no significant difference between both groups, though, despite the fact that workload for the high-intensity group was 33 % greater. Although the energy expenditure was larger in the high-intensity group, the energy intake may have been larger as well.

Finally, Thompson *et al*. (16) and King and Tribble (17) reviewed several weight loss studies involving physical exercise and concluded that the programs in which more weight losses were obtained were those including either intense training or long duration. They reported that loss of body fat is a long continual process that may be affected by changes in an individual's lean mass if total weight alone is evaluated. Therefore, studies focusing on loss of body fat should be at least 12 weeks long. Thompson *et al*. (16) also reported that exercise may affect appetite regulation, and when it is performed at low intensity it may lead to increased food intake. However, depending on energy expenditure, moderate exercise may stimulate food intake and thus result in controlled body weight. On the other hand, intense exercise will lead to decreased food intake and weight loss.

Studies have reported the effects of high-intensity physical exercise such as reduced subcutaneous adiposity through a certain caloric expenditure in leisure activities; increased fat mass loss; increased lypolitic activity (12); reduced post-exercise caloric compensation (18); and improved cardiorespiratory condition in basal metabolic rate and oxidation of fatty acids (19). In addition, a number of studies have shown that resting energy expenditure is increased by 5 to 15% for 24 to 48 hours after aerobic exercise of at least 70% of VO_2max, but not increase following aerobic exercise at lower intensity (20,21).

In conclusion, it appears that 14 weeks of HI exercise training is more effective in increasing fat loss than MI aerobic exercise in overweight young men.

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