



Determination of VO₂max response to exercise training and its relationship with anthropometrical indexes follow up exercise program

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Received: 12 October 2012

Revised: 26 November 2012

Accepted: 27 November 2012

Key words: Aerobic training, obesity, VO₂max, anthropometrical indexes.

Abstract

Accumulating evidence indicates that obesity and sedentary lifestyle is associated with low cardiovascular fitness. This study was conducted 1), to evaluate the effect of aerobic exercise training on maximal oxygen uptake (VO₂max) as a major marker of cardiovascular fitness in obese men 2), to determine the relationship between VO₂max with anthropometrical markers follow up exercise training in studied subjects. For this purpose, thirty sedentary middle-aged obese men were divided into exercise (aerobic training) and control (without exercise training) groups by randomly. Anthropometrical markers such as body mass index (BMI), abdominal circumference, body fat percentage and visceral fat and VO₂max were measured before and after an aerobic exercise program (3 months, 3 time/weekly) in exercise and control groups. At baseline, there were no differences in VO₂max and anthropometrical indexes between the two groups. VO₂max improved significantly after aerobic training when compared with baseline levels. Aerobic training also led to significant decrease in anthropometrical markers in exercise group. VO₂max was negatively significantly correlated with BMI, visceral fat and abdominal circumference and other anthropometrical markers after aerobic program in exercise group. All variables remained no change in control group. Based on this data, we conclude that decreased anthropometrical markers by aerobic training program are associated with an improvement in cardiorespiratory fitness in obese males.

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Introduction

Maximal oxygen uptake (VO₂max) is one factor determining aerobic capacity and refers to the maximum amount of oxygen that an individual can utilize during intense or maximal exercise. Review of research evidence shows that aging is associated with a progressive decline in the capacity for physical activity (Betik *et al.*, 2008). On the other hand, obesity has been associated with numerous health problems especially in middle-aged or elderly and is an important risk factor for adult morbidity and mortality (Must *et al.*, 1992; Gunnell *et al.*, 1998; Eriksson *et al.*, 1999).

There is considerable evidence that obesity is widely recognized as a contributing factor to various conditions such as: impaired glucose tolerance; type 2 diabetes; hyperlipidemia; hypertension and reduced cardiorespiratory/aerobic fitness (Sinha *et al.*, 2002). Preliminary human studies indicated that exercise confers significant health benefits to people with overweight and obesity even in the absence of weight loss. Epidemiologic studies clearly show that both the high body fatness and low aerobic fitness have been shown to be risk factors for cardiovascular disease (Jaswant *et al.*, 2010).

There is accumulating evidence in the literature that VO₂ max or maximal aerobic capacity is only a single measure of the functional capacity of the oxygen system or cardio-respiratory system or the oxygen transport system (Koley, 2007). Accumulating evidence indicates that obese and sedentary people have lower aerobic capacity and higher resting or exercise heart rate (HR) than Active people or athletes as well as normal weight subjects. It has been established that both stature and mass are highly correlated with VO₂max at baseline (Jaswant *et al.*, 2010). In this study, we investigated the effect of long term aerobic exercise training on VO₂max and anthropometrical parameters in a group of sedentary obese middle-aged men. We also evaluate whether there is a significant relationship between VO₂max and anthropometrical parameters following exercise training.

Subjects and methods

Thirty sedentary middle-aged obese men were recruited for participation in this study and divided to exercise and control groups by randomly. This study was conducted 1), to evaluate the effect of aerobic exercise training on maximal oxygen uptake (VO₂max) as a major marker of cardiovascular fitness in obese men 2), to determine the relationship between VO₂max with anthropometrical markers follow up exercise training in studied subjects.

Subjects were aged 34 - 40 years and body weight 96 - 114 kg. Participants were non-athletes, non-smokers and non-alcoholics. Neither the control or diabetic subjects had participated in regular exercise for the preceding 6 months, nor did all subjects have stable body weight. Daily food records were kept for 48 h preceding each test session, and subjects were instructed to refrain from caffeine consumption and intense physical activity for 24 h before testing. The exclusion criteria were infections, renal diseases, hepatic disorders, use of alcohol, and use of nonselective β blockers and presence of malignancy. Informed consent was obtained from each subject after full explanation of the purpose, nature and risk of all procedures used.

Anthropometric measurements (body height and weight, waist and hip circumference) were performed with the subjects wearing light underwear and without shoes. Abdominal obesity was determined as waist circumference measured in a standing position. BMI was calculated as weight in kilograms divided by the square of height in meters (kg/m²). Visceral fat and body fat percentage was determined using body composition monitor (OMRON, Finland).

Cardiorespiratory fitness was assessed as VO₂max (mL kg⁻¹ min⁻¹) was measured using a bicycle ergometer in a stepwise fashion according to YMCA instrument (Mullis *et al.*, 1999). The subjects were advised to avoid any physical activity or exercise 48 hours before each exercise test. Resting HR was

measured after a 15-min rest in a sitting position and in a quiet environment before exercise test for all participants. Exercise training program lasted 3 months (3 days/wk) 60 to 80 percent of maximum heart rate. Each session started by 15 min of flexibility exercises, 30-40 min of aerobic exercise and 5-10 min of cool down activity. Aerobic exercises in each session included walking on a treadmill and stationary cycling. Initially, subjects exercised at low intensity and the intensity of exercise was gradually increased to 80% of peak heart rate in next sessions. The intensity of the activity of any person was controlled using the Polar heart rate tester (made in the US). In this 12-week period, participants in the control group were barred from participating in any exercise training. All measurements were repeated after intervention program in two groups.

Statistical analysis

Statistic analysis was done with SPSS 15.0 for Windows. All values are given as mean and standard deviation. The Kolmogorov-Smirnov test was applied to determine the variables with normal distribution. An Independent sample T-test was used to compare all variables between exercise and control groups at baseline. Student's t-tests for paired samples were performed to determine significance of changes in variables by exercise intervention. The bivariate

associations between VO₂max with anthropometrical markers were examined with the Spearman rank correlation analysis was used in exercise group after exercise intervention. All statistical tests were performed and considered significant at a $P \leq 0.05$.

Results

Baseline and post training anthropometrical markers, resting heart rate and VO₂max are shown in Table 1. At baseline, there were no differences in the age, resting heart rate, VO₂max, body weight and other anthropometrical indexes between the two groups. Compared to pre-training, the VO₂max levels increased ($p = 0.000$) significantly after exercise program in exercise group but not in control group. Furthermore we observed a reduction in resting heart rate in exercise group after exercise program ($p = 0.001$). Body weight ($p = 0.009$), abdominal circumference ($p = 0.006$), body fat percentage ($p = 0.000$), body mass index ($p = 0.004$) and other anthropometrical markers were significantly reduced in exercise group but not in control subjects. VO₂max was negative significantly correlated with BMI ($p = 0.006$, $r = 0.69$), body fat percentage fat ($p = 0.038$, $r = 0.56$) and visceral fat ($p = 0.021$, $r = 0.61$) and other anthropometrical markers after aerobic program in exercise group. All variables remained no change in control group.

Table 1. Mean and standard deviation of anthropometrical and VO₂max before and after intervention in studied groups.

Variables	Control group		Exercise group	
	Pretest	post-test	Pretest	post-test
Age (year)	34.12 ± 4.3	34.12 ± 4.3	35 ± 4.3	35 ± 4.3
Height (cm)	176.2 ± 4.3	176.2 ± 4.5	177 ± 2.61	177 ± 2.61
Weight (kg)	103.3 ± 11.3	102.6 ± 9.8	102 ± 13.17	95.44 ± 13.17
Abdominal circumference (cm)	108.5 ± 9.45	107 ± 8.5	108.38 ± 10.99	103.4 ± 10.76
Hip circumference (cm)	108.35 ± 4.6	107.44 ± 4.2	108.88 ± 10.03	104.13 ± 9.86
BMI (kg/m ²)	33.27 ± 2.14	33.04 ± 3.18	32.55 ± 3.11	30.46 ± 3.23
Body fat (%)	31.98 ± 3.12	30.87 ± 3.3	32.38 ± 3.20	27.56 ± 2.56
Visceral fat	13.8 ± 2.3	13.55 ± 2.14	14 ± 2	11.88 ± 2.03
Resting heart rate (bpm)	81 ± 5.6	80 ± 5.6	80 ± 4.6	68 ± 6.82
VO ₂ max (ml.kg.min)	25.6 ± 4.8	26.3 ± 4.6	26.16 ± 3.93	31.76 ± 5.22

Discussion

The major finding of present study was increased VO₂max after aerobic exercise training when compared to baseline in exercise group. On the other hand, aerobic training for three months with %60-80 HRmax resulted in a remarkable improvement (21%) in VO₂max in middle-aged obese men. Resting heart rate was also decreased in response to exercise training.

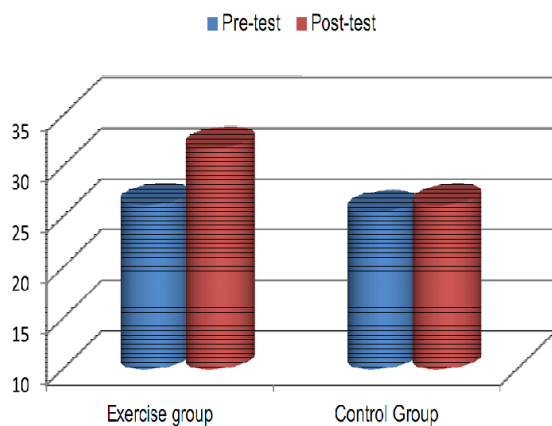


Fig. 1. The changes pattern of Vo₂max, before and after intervention program in two groups. This diagram showed that exercise program increases VO₂max in obese men but not in control group.

VO₂max also known as functional aerobic capacity represents the maximal rate of oxygen utilization by exercising muscles and is considered the outstanding factor measure of the functional limit of the cardiorespiratory system (Saltin *et al.*, 1991).

Assessment of VO₂max Enables physicians in diagnosis individuals who may have difficulty performing various functional tasks, as the energy requirements (oxygen uptake) for many physical tasks have been determined and are now readily available (Morey *et al.*, 1998).

Body composition the main component of health related fitness refers to the relative amounts to fatty tissue devoid of fat free mass i.e. muscle, bone and water and VO₂max as a marker indicative of Cardio-respiratory fitness represents the functional capacity of heart, blood vessels, lungs and related muscles while individual performing different kinds of physical activities. Close relationship between VO₂max and body composition

determinative was reported by some authors (Jaswant *et al.*, 2010). Also, it has been previously reported that excess fatness accelerated low aerobic capacity (Rump *et al.*, 2002).

Tendency to obesity and overweight on the one hand and Physical inactivity or sedentary lifestyle patterns on the other hand, both play key role in low cardiorespiratory particularly in middle-aged or elderly people. Although many factors are involved, basically the cause of too much fat being deposited depends on the imbalance between energy consumption and expenditure (Swinburn *et al.*, 2006), physical inactivity is considered to play a major role in the development of obesity (Powell *et al.*, 1994) and improving in VO₂max as cardiorespiratory fitness.

In the light of these observations, our finding in present study supports the beneficial effects of aerobic training on cardiorespiratory or aerobic capacity as well as resting heart rate in obese men. In present study, we also observed that aerobic training was associated with significant decreased in anthropometrical markers such as abdominal obesity, body fat percentage, body mass index and visceral fat in exercise group. Based on these data, we can conclude that improvement in body composition follow up long term exercise training is associated with increased VO₂max. On the other hand, in this study, a negative significant correlation was observed between VO₂max with abdominal circumference, BMI and visceral fat in exercise group.

In conclusion, the findings of this study indicate that aerobic exercise program for three months significantly increased VO₂max as a leading indicator of cardiorespiratory fitness in obese middle-aged individuals. This training program also significantly decreased resting heart rate which is another determinant of cardiovascular fitness. Furthermore, a significant correlation between VO₂max levels and other body composition indicators such as BMI and

abdominal circumference and visceral fat suggest that improved body composition in response to aerobic exercise program in obese subjects can be regarded as an important factor in the increase of VO₂max. Overall, these findings support the role of exercise-induced weight loss in improving cardiorespiratory fitness in people previously classified as obese.

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