

Cardiopulmonary Adaptation Response to Aerobic and Anaerobic Exercise Training in Obese Subjects

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ABSTRACT

Objective: This study was designed to determine changes in cardiopulmonary functions after aerobic and anaerobic exercise training in obese subjects. **Subjects, material and methods:** Thirty obese adult subjects, their age ranged between 20 to 28 years old and divided into two equal groups. The first group performed aerobic exercise training program the duration of exercise was 12 weeks, at a frequency of 4 sessions per week in addition to diet regimen and the second group performed anaerobic exercise training program the duration of exercise was 12 weeks, at a frequency of 2 sessions per week in addition to diet regimen. Cardiopulmonary functions were measured for both groups before and after the exercise program. **Results:** Both aerobic and anaerobic exercise training program produced significant increase in cardiopulmonary functions, where aerobic exercise group indicated a significant improvement in the Cardiopulmonary functions but the anaerobic exercise program indicated no significant changes in the Cardiopulmonary functions. **Conclusion:** It is recommended to use aerobic exercise and diet regimen in order to reduce weight and improve cardiopulmonary fitness in obese subjects.

INTRODUCTION

Obesity is an increasingly significant health problem. Over 4 decades, the prevalence of obesity (a body mass index [BMI] ≥ 30 kg/m²) has increased from 13% to 31% in adults. Concurrent increases occurred in adolescents and children¹³.

Obesity-related chronic conditions cause direct and indirect health care costs. Increasing BMI associates with increasing medical service use, such as medication use, visits to hospital emergency departments, doctor visits, and visits to outpatient clinics^{8,16}.

Increasing levels of physical activity in obese subjects are associated with a decrease in cardiovascular problems. Controlled clinical

trials suggest that exercise has benefits in persons with coronary artery disease and in those with glucose intolerance. Exercise produces improvements in mood, blood pressure, insulin sensitivity, and plasma lipoprotein profiles¹⁸.

The purpose of this study is to compare between the therapeutic efficacy of aerobic and anaerobic exercise program on cardiopulmonary function in obese subjects.

SUBJECTS, MATERIAL AND METHODS

Healthy thirty obese adolescent males (body mass index ranged between 30 to 37 kg/m²) were selected. Their ages ranged from 20 to 26 years old. They divided randomly into two equal groups. The first group participated

in the aerobic exercise program and diet for 12 weeks, while the second group enrolled in anaerobic exercise and diet program for 12 weeks. Subjects who suffer from any cardiovascular, pulmonary disease, orthopedic or neurological disorders excluded from the study.

EQUIPMENTS

A- Assessment equipment

Cardiopulmonary exercise test unit (CPET): (Zan 800; made in Germany). It consists of breath gas (O₂ and CO₂) analyzer, electronic treadmill, 12 channels electrocardiogram, (ECG) monitor, gas bottle and mask with a diaphragm to analyze gas. The speed and the inclination of treadmill were be controlled by pre-selected soft ware (Bruce standard protocol)¹. The final test results were print out by the printer. This unit was calibrated daily.

B- Monitoring equipment

1-Mercury sphygmomanometer: (Diplomat, Presameter made in Germany) and stethoscope (Riester, duplex, made in Germany); it was used to measure blood pressure before, and after exercise training sessions.

2- Pulsometer: (Tunturt TPM-400, made in Japan) it was used to detect pulse rate before, during and after exercise.

C -Training equipment

* **Electronic Treadmill:** (RAM CE, made in Germany) its speed and inclination and timer are adjustable, and it also provided with control panel to display the exercise parameters.

PROCEDURES OF THE STUDY

The procedures of this study were divided into two main procedures.

1- Evaluation procedures

Before starting the study, a consent form was taken from each participant as an agreement to be included in the present study also before initiation of exercise training program each subject was examined medically by a physician in order to exclude any abnormal medical problems which previously mentioned. A brief description had been given about the tasks expected during the test.

2-Cardiopulmonary exercise test procedure (CPET)

Before conducting the exercise tolerance test, all subjects had to visit the laboratory to be familiarized with the equipment in order to be cooperative during conducting the test. Each subject underwent continuous progressive exercise tolerance test according to Bruce standard protocol which consists of warming up phase and five active phases and recovery phase.

3-Myocardial oxygen consumption

It was calculated by the formula of $HR = (HR \times SBP) \times 10^2$.

Where HR = Heart rate, SBP =systolic blood pressure¹²

Measurements included systolic blood pressure, diastolic blood pressure, heart rate, maximum voluntary ventilation (MVV), myocardial oxygen consumption and body mass index (BMI). Measurements taken before the study and after 12 weeks at the end of the study.

4- Training procedures

Group (1): Patients in this group received aerobic exercise training for 12 weeks in addition to low caloric diet regimen as following:

A-Warming up: Before the exercise program, include walking on the treadmill for 5

minutes at speed 1.5 km/h with zero inclination.

B- Active phase: It was gradually increased from 20 to 40 minutes in the form of walking/running on electronic treadmill with zero inclination four times per week for twelve weeks, its intensity gradually from 60 to 80 % of maximum heart rate.

C- Cooling down: Included walking on the treadmill for 5 minutes at speed 1 km/h with zero inclination and gradually decreased speed until reach zero¹⁴.

Group (2): Patients in this group received anaerobic exercise training for 12 weeks in addition to low caloric diet regimen as following:

1-Warming up: Before the exercise program, include walking on the treadmill for 5 minutes at speed 1.5 km/h with zero inclination.

2-Active phase: Started firstly with 2 minutes gradually increased 5 second each session until reach 3 minutes then rest for 2 minute this bout was repeated 5 times each session in the form of running on electronic treadmill gradually from 85% to 93% of maximum heart rate with frequency of two

times per week for twelve weeks gradually from 85% to 93% of maximum heart rate⁹.

3- Cooling down: Included walking on the treadmill for 5 minutes at speed 1 km/h with zero inclination and gradually decreased speed until reach zero.

Statistical Analysis

The paired t-test was used to compare between pre and post test in both groups, where the independent t- test was used for the comparison between the two groups ($p < 0.05$).

RESULTS

This study comprised 40 obese adult subjects selected from Cairo University. The data was collected from subjects and classified into pre and post test values. The subjects were divided into 2 groups: Group (I) received aerobic exercise in addition to diet regimen and group (II) received anaerobic exercise in addition to diet regimen.

Table (1) and figure (1) show the difference of mean and standard deviation values of body mass index (BMI) between both groups before and after the exercise program.

Table (1): Statistical analysis of body mass index (BMI) between both groups before and after the exercise program.

	Aerobic group	Anaerobic group	t-value	Significance
Pre	36.45±3.36	35.95±3.72	0.83	Non sig.
Post	30.01±2.56	33.54±2.26	2.82	Sig.
t-value	-3.51	-2.76		
Significance	Sig.	Sig.		

Level of significance $P < 0.05$

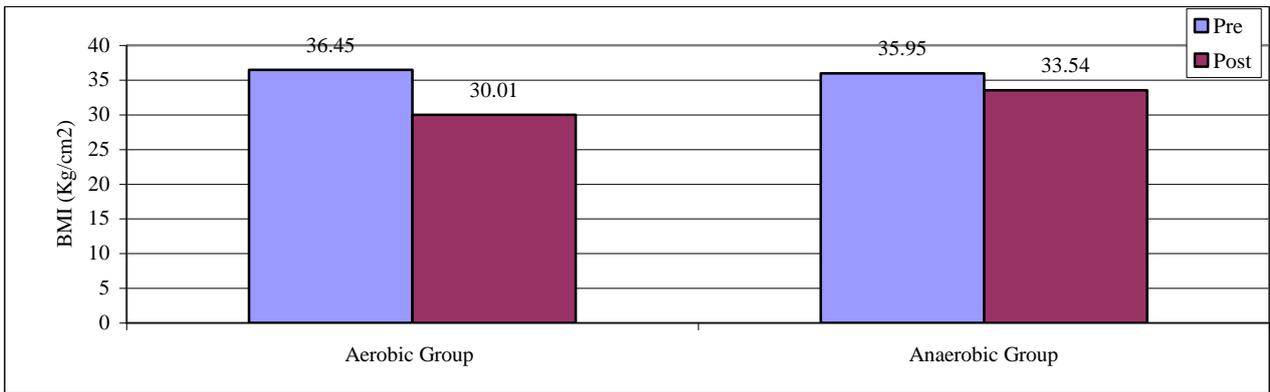


Fig. (1): Statistical analysis of body mass index (BMI) between both groups before and after the exercise program.

Table (2) and figure (2) show the difference of mean and standard deviation values of maximum voluntary ventilation (MVV) between both groups before and after the exercise program.

Table (2): Statistical analysis of maximum voluntary ventilation (MVV) between both groups before and after the exercise program.

	Aerobic group	Anaerobic group	t-value	Significance
Pre	96.2±10.8	98.02±7.7	0.6	Non sig.
Post	126.6±16.6	104.4±11.9	3.02	Sig.
t-value	12.4	4.3		
Significance	Sig.	Sig.		

Level of significance p<0.05

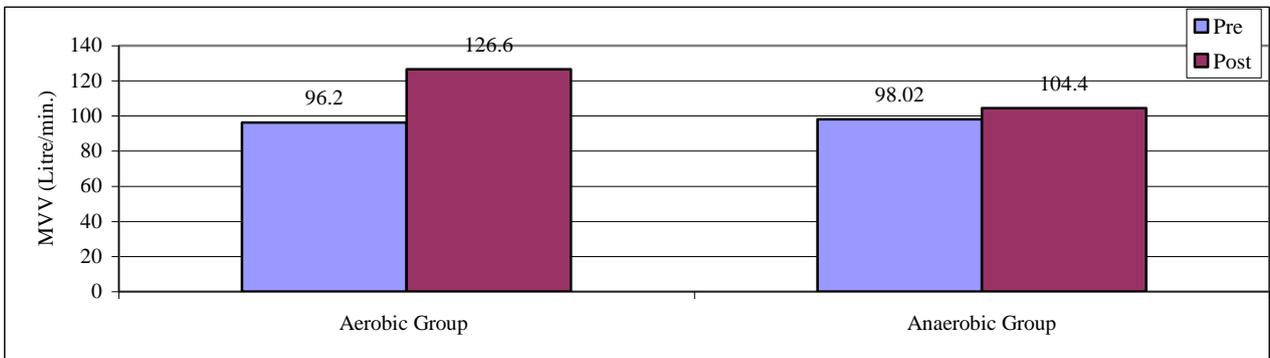


Fig. (2): Statistical analysis of maximum voluntary ventilation (MVV) between both groups before and after the exercise program.

Table (3) and figure (3) show the difference of mean and standard deviation values of heart rate between both groups before and after the exercise program.

Table (3): Statistical analysis of heart rate between both groups before and after the exercise program.

	Aerobic group	Anaerobic group	t-value	Significance
Pre	82.1±2.7	81.6±3.6	0.5	Non sig.
Post	74.3±3.8	82±4.6	3.5	Sig.
t-value	-8.801	-0.479		
Significance	Sig.	Non sig.		

Level of significance P<0.05

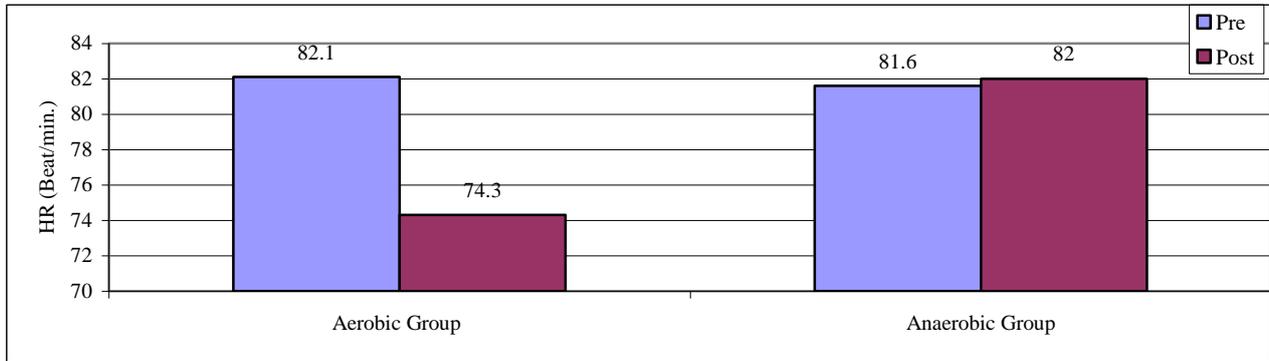


Fig. (3): Statistical analysis of heart rate between both groups before and after the exercise program.

Table (4) and figure (4) show the difference of mean and standard deviation values of systolic blood pressure between both groups before and after the exercise program.

Table (4): Statistical analysis of systolic blood pressure between both groups before and after the exercise program.

	Aerobic group	Anaerobic group	t-value	Significance
Pre	136±5.9	136.5±4.8	0.25	Non sig.
Post	124.5±6.8	136.5±5.8	3.7	Sig.
t-value	-5.2	-0.01		
Significance	Sig.	Non sig.		

Level of significance P<0.05

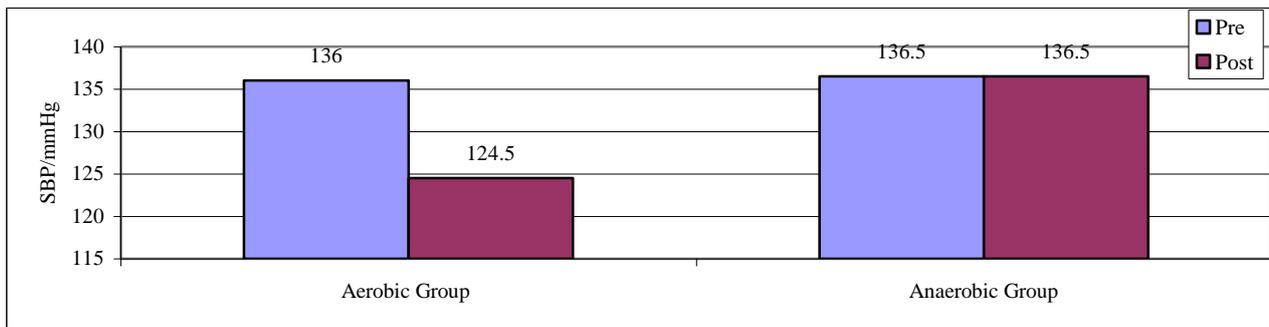


Fig. (4): Statistical analysis of systolic blood pressure between both groups before and after the exercise program.

Table (5) and figure (5) show the difference of mean and standard deviation values of diastolic blood pressure between both groups before and after the exercise program.

Table (5): Statistical analysis of diastolic blood pressure between both groups before and after the exercise program.

	Aerobic group	Anaerobic group	t-value	Significance
Pre	87.5±4.4	88±4.1	0.37	Non sig.
Post	80.1±5.02	88.5±3.6	3.8	Sig.
t-value	-8.5	-1.1		
Significance	Sig.	Non sig.		

Level of significance $P < 0.05$

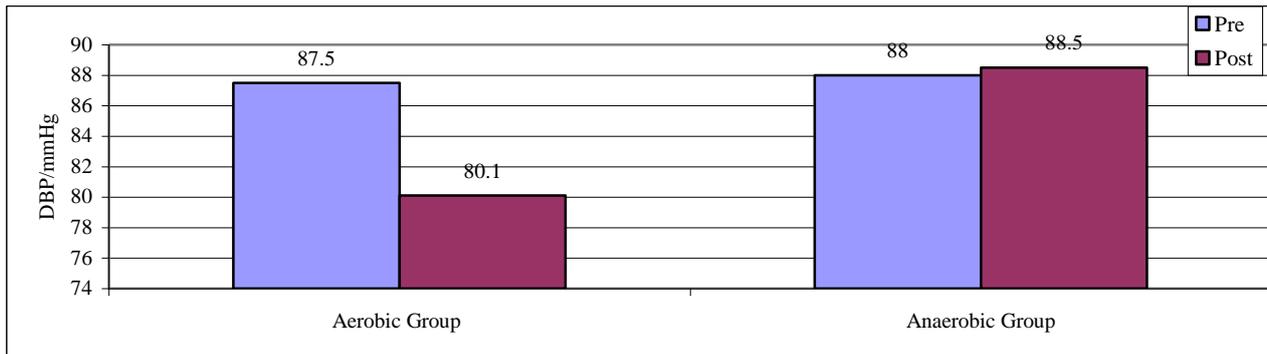


Fig. (5): Statistical analysis of diastolic blood pressure between both groups before and after the exercise program.

Table (6) and figure (6) show the difference of mean and standard deviation values of myocardial oxygen consumption between both groups before and after the exercise program.

Table (6): Statistical analysis of myocardial oxygen consumption between both groups before and after the exercise program.

	Aerobic group	Anaerobic group	t-value	Significance
Pre	113.49±12.29	115.35±11.37	0.37	Non sig.
Post	91.98±7.73	112.85±11.38	4.23	Sig.
t-value	-12.5	-1.1		
Significance	Sig.	Non sig.		

Level of significance $P < 0.05$

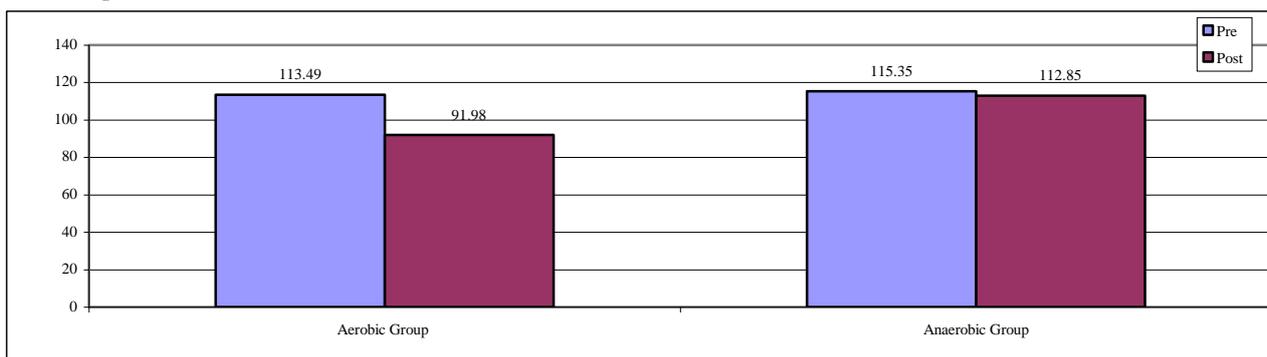


Fig. (6): Statistical analysis of myocardial oxygen consumption between both groups before and after the exercise program.

DISCUSSION

The aim of this study was to analyze the changes in cardio pulmonary functions after aerobic and anaerobic exercise program in obese adult subjects.

The measures in this study were body mass index (BMI) and cardiopulmonary functions which were myocardial oxygen consumption, heart rate, systolic and diastolic blood pressure and maximum voluntary ventilation (MVV). A comparison was made between the effect of aerobic exercise and the anaerobic exercise.

The results indicated that there was a significant reduction in body mass index in both aerobic and anaerobic exercise group. But the reduction in the aerobic exercise group was higher than the reduction in the anaerobic exercise group.

This results is supported by studies indicated that aerobic exercise induce significant reduction in body mass index which is associated with subsequent cardiovascular risk factors so this reduction will reduce the risk of cardiovascular disease in this subjects^{15,19}.

The results also indicated that there was a significant increase in maximum voluntary ventilation in both aerobic exercise group and anaerobic exercise group. Where aerobic exercise group obtained a greater increase in MVV than anaerobic exercise program.

This result is supported by a study reported that aerobic training induces significant physiological adaptations in the cardio-respiratory system of middle-aged men. The best markers of these adaptations were the smaller sympathetic tachycardia at comparable workloads and the improvement of oxygen transport, as documented by the increase in the anaerobic threshold and VO_2 peak during dynamic exercise^{3,4}.

This result also supported by a study compared the cardio-pulmonary function between moderate exercise program and severe exercise program and they reported that there was significant improvement in VO_2 max and maximum voluntary ventilation after both types of exercise⁷. The results also indicated that there was a significant reduction in heart rate, systolic and diastolic blood pressure in the aerobic exercise group at the end of aerobic exercise program.

Regular aerobic training induces significant adaptations both at resting and during maximum exercise in a variety of dimensional and functional capacities related to the cardiovascular and respiratory regulation system, enhancing the delivery of oxygen into active muscles. These changes include decreases in resting and maximal exercise heart rate, enhanced stroke volume and cardiac output^{6,17}. The reduction of heart rate, systolic and diastolic blood pressure in the aerobic exercise group after aerobic training was due to Nitric oxide might be an important and potent endothelium-derived relaxing factor that facilitates blood vessel dilatation and decreases vascular resistance¹⁰.

The results also indicated that there were no significant changes in heart rate, systolic and diastolic blood pressure in the anaerobic exercise group after finishing the program of anaerobic exercise. But there was significant reduction after aerobic exercise program. This reflects an increased cardio respiratory load related to the prolonged duration of training session from 20 to 30 minutes. However, the greater blood flow under the influence of the rise in heart rate and systolic blood pressure does not satisfy the increased oxygen requirements during anaerobic exercise. This explains the significant augmentation of pulmonary ventilation and ventilation capacity in a trial to satisfy the expanding oxygen

transport requirements during maximal exercise. Participation in heavy resistance anaerobic training over extended period of time increases cardiac work and thus it couldn't be sustained over extended period of time⁵.

The results also indicated that there were no significant changes in myocardial oxygen consumption after finishing the program of anaerobic exercise. But there was significant reduction after aerobic exercise program.

The improvement of resting heart rate and systolic blood pressure were reflected on myocardial oxygen consumption in this study. This improvement of myocardial oxygen consumption might be due to improvement in endothelium-dependant vasodilatation both in epicardial coronary vessels. Also it might be due to recruitment of coronary collateral vessels and enhanced blood flow with regulation of vasomotor tone toward vagal modulation. The myocardial oxygen consumption was lowered after eight weeks training program at 60 to 80 % of maximum HR. This improvement might be due to increased peripheral vasodilatation and, consequently, decreased after load following exercise and a reduction in adrenergic efferent stimuli^{2,11}.

From the previous discussion and according to the reports of the investigators in fields related to the present study, it can be concluded that aerobic exercise improves cardiorespiratory fitness in obese subjects with less cardiac work as evidenced by the low myocardial oxygen consumption. While anaerobic exercise increases cardiac work and it is difficult to be maintained for extended periods of time, Moreover low-intensity aerobic exercise is less difficult; more easily tolerated and can be practiced daily over an extended period of time.

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الملخص العربي

استجابة تكيف الجهاز الدوري التنفسي للتمرينات الهوائية واللاهوائية في الأشخاص البدناء

هدف الرسالة هو دراسة تأثير إنقاص الوزن و التمرينات الهوائية واللاهوائية على الوظائف القلبية الرئوية لدى البدناء . أجرى البحث على ثلاثين شخص من البدناء وتم تقسيمهم إلى مجموعتين متساويتين : المجموعة الأولى تلقت تمرينات هوائية لمدة اثني عشر أسبوعا بمعدل أربعة جلسات أسبوعيا بالإضافة إلى نظام غذائي . المجموعة الثانية تلقت تمرينات لا هوائية وكانت مدة التمرينات اثني عشر أسبوعا بمعدل جلستان أسبوعيا بالإضافة إلى نظام غذائي . وقد تم قياس الوظائف الرئوية القلبية قبل بدء البرنامج وبعد الانتهاء من البرنامج. وقد أظهرت النتائج وجود فروق ذات دلالة إحصائية تشير إلى وجود تحسن ملحوظ في الوظائف الرئوية في المجموعتين . وأظهرت مجموعه التمرينات الهوائية فروق ذات دلالة إحصائية في الوظائف الرئوية القلبية في حين لم تظهر مجموعه التمرينات اللاهوائية أية فروق ذات دلالة إحصائية في الوظائف الرئوية القلبية مما يضع حملا على عضلة القلب أثناء ممارسة هذه التمرينات لذلك.