Cardiopulmonary Adaptation Response to Exercises Training in Obese Subjects

Shehab M. Abd El-Kader
Department of Physical Therapy for Cardiopulmonary Disorders and Geriatrics , Faculty of Physical Therapy, Cairo University .

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 has increased from 13% to 31% in adults Concurrent increases occurred in adolescents and children[13].Obesity-related chronic conditions cause direct and indirect health care costs. [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 profiles[18].

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/m^2) were selected ,their ages ranged from 20 to 26 years old. They divided randomly into two equal groups. Subjects who suffer from any cardiovascular, pulmonary disease, orthopedic or neurological disorders excluded from the study.

EQUIPMENT

A- Assessment equipment

1-Cardiopulmonary exercise test unit (CPET): (Zan 800; made in Germany). It consists of breath gas (O_2 and CO_2) 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.

2-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.

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

B -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.

I - 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.

1-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.

2-Myocardial oxygen consumption

It was calculated by the formula of HR = (HR X SBP) x 10^2.

Where HR = Heart rate, SBP =systolic blood pressure[12]

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.

II - Training procedures

Group (1): They received aerobic exercise training for 12 weeks in addition to low caloric diet regimen. Exercise training program consisted of warming up in the form of walking on the treadmill for 5 minutes at speed 1.5 km/h with zero inclination , the active phase which was gradually increased from 20 to 40 minutes in the form of walking/running on electronic treadmill with zero inclination four times per weak for twelve weeks, its intensity gradually from 60 to 80 %

of maximum heart rate and cooling down that included walking on the treadmill for 5 minutes at speed 1 km/h with zero inclination and gradually decreased speed until reach zero[14].

Group (2): They received anaerobic exercise training for 12 weeks in addition to low caloric diet regimen . Exercise training program consisted of warming up in the form of walking on the treadmill for 5 minutes at speed 1.5 km/h with zero inclination , the active phase which 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 weak for twelve weeks gradually from 85% to 93% of maximum heart rate[9].The 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

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	P >0.05
Post	30.01±2.56	33.54±2.26	2.82	P < 0.05
t-value	-3.51	-2.76		
Significance	P < 0.05	P < 0.05		

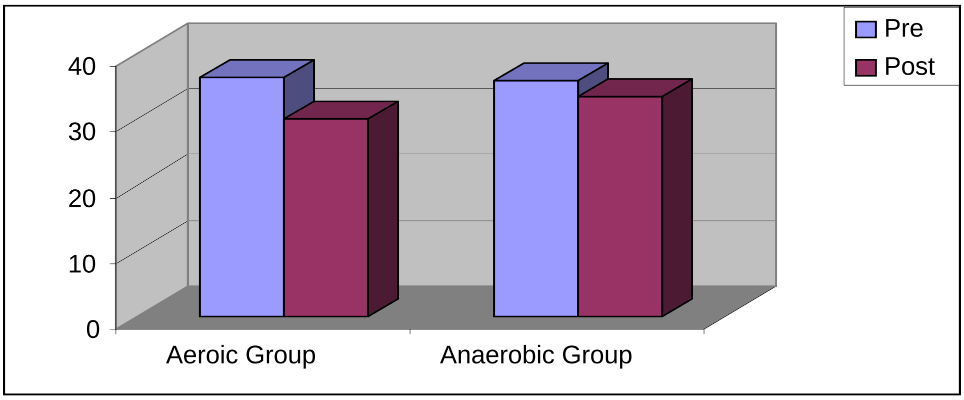
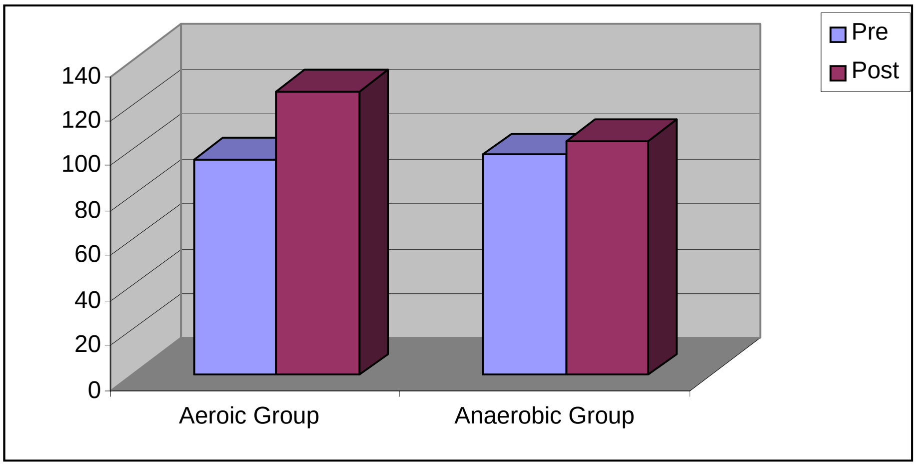


Figure (1): Statistical analysis of body mass index (BMI) between both groups before and after the exercise program.

Table (2) and figure (2) show the difference of mean & standard deviation 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	P >0.05
Post	126.6±16.6	104.4±11.9	3.02	P < 0.05
t-value	12.4	4.3		
Significance	P < 0.05	P < 0.05		



Figure(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	P >0.05
Post	74.3±3.8	82±4.6	3.5	P < 0.05
t-value	-8.801	-0.479		
Significance	P < 0.05	P >0.05		

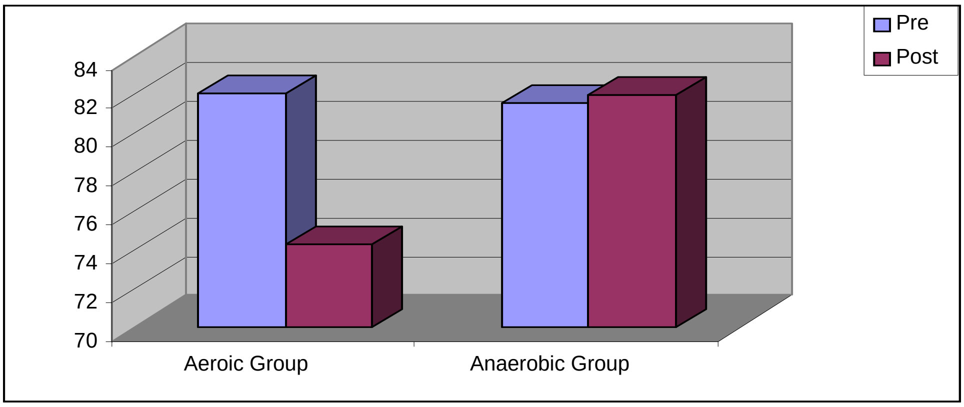


Figure (3): Statistical analysis of heart rate between both groups before and after the exercise program.

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): 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	P >0.05
Post	124.5±6.8	136.5±5.8	3.7	P < 0.05
t-value	-5.2	-0.01		
Significance	P < 0.05	P >0.05		

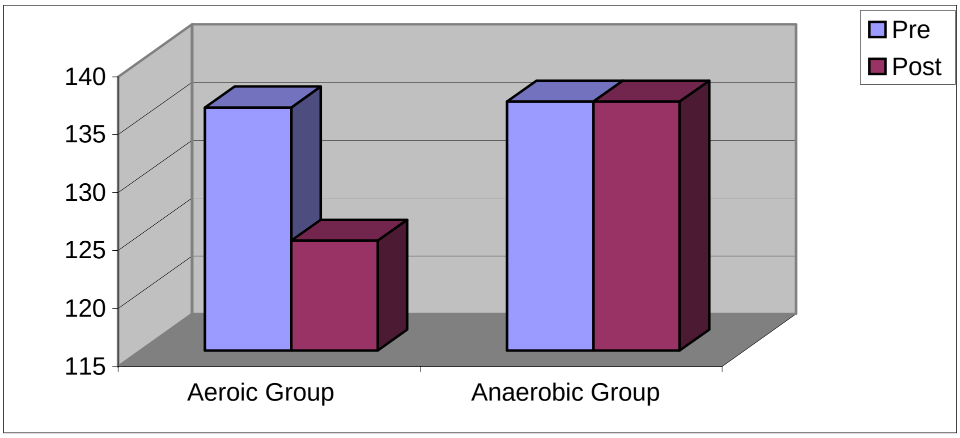


Figure (4): Heart rate between both groups before and after the exercise program.

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):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	P >0.05
Post	80.1±5.02	88.5±3.6	3.8	P < 0.05
t-value	-8.5	-1.1		
Significance	P < 0.05	P >0.05		

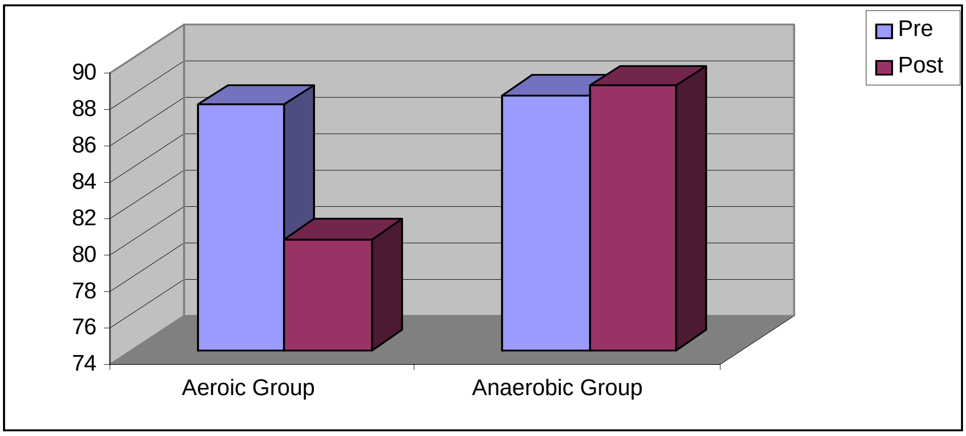


Figure (5):Diastolic blood pressure between both groups before and after the exercise program.

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):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	P >0.05
Post	91.98±7.73	112.85±11.38	4.23	P < 0.05
t-value	-12.5	-1.1		
Significance	P < 0.05	P >0.05		

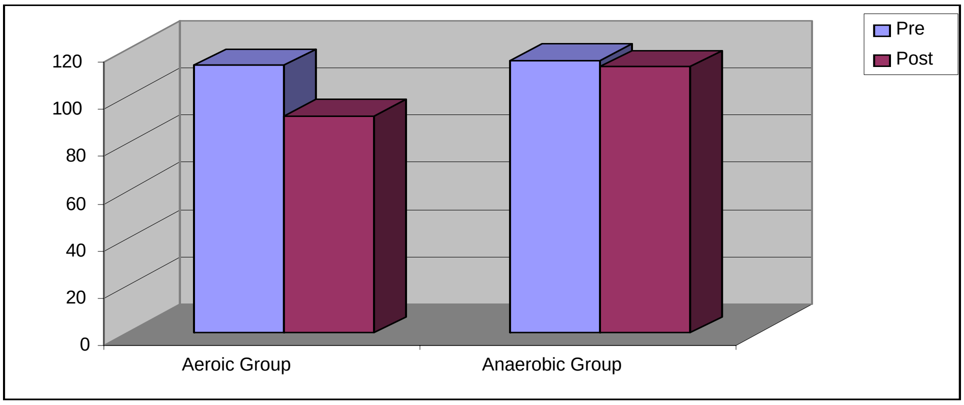


Figure (6):Myocardial oxygen consumption between both groups before and after the exercise program.

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 are 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 is 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 exercise[7].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 might be due to Nitric oxide, an important and potent endothelium-derived relaxing factor, that facilitates blood vessel dilatation and decreases vascular resistance[10].

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 doesn't 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 time[5].

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 are 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 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 improvements 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.

Conclusion

It is recommended to use aerobic exercise and diet regimen in order to reduce weight and improve cardiopulmonary fitness in obese subjects.

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الملخص العربي

استجابة تكيف الجهاز الدورى التنفسى للتمرينات فى الاشخاص البدناء

هدف الدراسة هو معرفة تأثير إنقاص الوزن و التمرينات الهوائيه واللاهوائيه على الوظائف القلبيه الرئويه لدى البدناء. أجرى البحث على ثلاثين شخص من البدناء و تم تقسيمهم الى مجموعتين متساويتين: المجموعة الأولى تلقت تمرينات هوائيه لمدة اثنى عشر اسبوعا بمعدل اربعة جلسات اسبوعيا بالاضافة الى نظام غذائى. المجموعة الثانية تلقت تمرينات لاهوائيه وكانت مدة التمرينات اثنى عشر اسبوعا بمعدل جلستان اسبوعيا بالاضافة الى نظام غذائى.وقد تم قياس الوظائف الرئويه القلبيه قبل بدء البرنامج وبعد الانتهاء من البرنامج. وقد أظهرت النتائج وجود فروق ذات دلالة إحصائية تشير إلى وجود تحسن ملحوظ في الوظائف الرئويه في المجموعتين.واظهرت مجموعه التمرينات الهوائيه فروق ذات دلالة إحصائية فى الوظائف الرئويه القلبيه فى حين لم تظهر مجموعه التمرينات الاهوائيه اية فروق ذات دلالة إحصائية فى الوظائف الرئويه القلبيه مما يضع حملا على عضلة القلب اثناء ممارسة هذه التمرينات لذاك.