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Original Article

Aerobic and anaerobic exercise training in obese adults

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Abstract. [Purpose] Obesity is a global health problem and is associated with a multitude of complications. This study was designed to determine changes in cardiopulmonary functions after aerobic and anaerobic exercise training in obese subjects. [Subjects and Methods] Forty obese subjects, whose ages ranged between 18 and 25 years, were divided into 2 equal groups: group A received aerobic exercise training in addition to dietary measures, and group B received anaerobic exercise training for 3 months in addition to dietary measures. Measurements of systolic blood pressure, diastolic blood pressure, heart rate, maximum voluntary ventilation, maximal oxygen consumption, and body mass index were obtained for both groups before and after the exercise program. [Results] The mean body mass index, systolic blood pressure, diastolic blood pressure, heart rate, and maximal oxygen consumption decreased significantly, whereas the mean maximum voluntary ventilation increased significantly after treatment in group A. The mean maximum voluntary ventilation also increased significantly after treatment in group B. There were significant differences between the mean levels of the investigated parameters in groups A and B after treatment. [Conclusion] Aerobic exercise reduces weight and improves cardiopulmonary fitness in obese subjects better than anaerobic exercise.

Key words: Obesity, Aerobic, Anaerobic

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INTRODUCTION

Obesity is a leading threat to the health of children and adolescents. Genetic factors, medical conditions, medications, and environmental factors are the most common causes of childhood obesity, which is usually managed through a diet regimen, exercise, and surgical treatment[1–3)].

The prevalence of overweight and obese individuals is increasing at an alarming rate, and obesity has become one of the most important avoidable and independent risk factors for morbidity and mortality[4)].

A successful weight management program must include dietary adjustments, increased physical activity, and behavior modifications. Nutrition modification should take into account the diet's energy content, composition, and suitability for individual patients[5)].

The European standards for energy-restricted diets have been established, but leave little flexibility for change. Three categories prevail: very low-calorie diets [450–800 kcal], low-calorie diets [800–1200 kcal], and meal replacements [200–400 kcal][6)].

Obesity in children has been associated with lower levels of physical activity and fitness. Research examining maximal oxygen consumption (VO_2 max) in obese and non-obese children indicates a significant difference in exercise tolerance[7)]. Physical activity and exercise are essential elements in obesity treatment, and regular physical activity has also been shown to lessen the burden of obesity-related comorbidities[8)].

Physical activity, without a reduction in calorie intake, usually has no relevant effect on weight. Although it is possible to lose weight through physical activity alone, the amount of physical activity required for substantial weight loss is well beyond what is feasible for most people in today's world. For instance, it would take more than 1–2 hours of very vigorous activity per day for children to achieve the desired weight loss[9)].

The purpose of this study was to determine changes in cardiopulmonary functions after aerobic and anaerobic exercise training in obese participants, with the aim to identify the most appropriate types of exercise training programs for these individuals.

SUBJECTS AND METHODS

Forty obese subjects, whose ages ranged from 18 to 25 years, participated in this study. Subjects suffering from any cardiovascular, pulmonary, orthopedic, or neurologi-

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cal disorders were excluded from the study. Patients were divided into 2 equal groups: group A received aerobic treadmill walking exercise training for 3 months, at a frequency of 3 sessions per week, in addition to dietary measures. The second group, group B, received anaerobic exercise training for 3 months, at a frequency of 3 sessions per week, in addition to dietary measures. All participants were free to withdraw from the study at any time. In the event of occurrence of any adverse effects, the experiment would have been discontinued, and the Human Subjects Review Board was informed regarding this. However, no adverse effects occurred, and data of all participants were available for analysis. This study was approved by the ethics committee, and all participants gave their informed consent. This study was conducted at the King Abdulaziz University Hospital in Saudi Arabia.

Cardiopulmonary exercise test unit (CPET): (Zan 800, Germany). The CPET consisted of a breath gas (O_2 and CO_2) analyzer, an electronic treadmill, a 12-channel electrocardiogram, (ECG) monitor, a gas bottle, and a mask with a diaphragm to analyze gas, which was used to measure VO_2 max and in-exercise training. The speed and inclination of the treadmill were controlled by pre-selected software (standard Bruce protocol). The final test results were printed. This unit was calibrated daily, as its speed, inclination, and timer are adjustable. It also featured a control panel to display the exercise parameters.

Pulsometer (Tunturt TPM-400, Japan): This was used to detect pulse rate before, during, and after exercise. A spirometer (Schiller-Spirovit Sp-10, Switzerland) was used to measure maximum voluntary ventilation (MVV). A mercury sphygmomanometer (Diplomat, Presameter) and stethoscope (Riester, duplex, Germany) were used to measure blood pressure before and after exercise training sessions.

Before starting the study, each participant completed a consent form as an agreement to be included in the present study. Additionally, before initiation of the exercise training program, each subject was examined medically by a physician in order to exclude subjects with any of the medical problems listed above in the exclusion criteria. A brief description of the tasks expected during the test was provided to the subjects.

Before conducting the exercise tolerance test, all subjects were asked to visit the laboratory to get familiar with the equipment for ensuring cooperation during the test. The treadmill had front and side rails to aid subject stability. Each subject underwent a continuous progressive exercise tolerance test to measure VO_2 max., in accordance with the standard Bruce protocol, which consisted of a warm-up phase, 5 active phases, and a recovery phase.

Measurements of systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), MVV, VO_2 max, and body mass index (BMI) were obtained for both groups before and after the exercise program.

The aerobic treadmill-based training program (Zan 800, made in Germany) was started with a 5-minute warm-up phase performed on the treadmill at a low load. The active phase of the training session was gradually increased from 20 to 30 minutes in the form of walking/running on the electronic treadmill with zero inclination 3 times per week for 12 weeks, its intensity being increased gradually from 60% to 70% of the maximum HR (HRmax) achieved in a reference, which was performed in accordance with a modified Bruce protocol. This rate was defined as the training HR (THR). The session ended with a 5-minute recovery and relaxation phase[10]. The anaerobic treadmill-based training program (Zan 800, made in Germany) was started with a 5-minute warm-up phase performed on the treadmill at a low load. Initially, the active phase of the training session was 2 minutes long, and this was gradually increased by 5 seconds in each session until 3 minutes, followed by rest for 2 minutes; this was repeated 5 times during each session in the form of running on the electronic treadmill, with a gradual increase from 70% to 80% of the HRmax, according to a modified Bruce protocol. This rate was defined as the THR. The session ended with a 5-minute recovery and relaxation phase. All patients performed 3 weekly sessions. HRmax = 220−age[11, 12].

The interview-based food survey was administered to all patients by dieticians to identify previous food habits and possible anomalies in dietary behavior. The prescribed low-calorie diet was balanced, with 15% as protein, 30–35% as fat, and 50–55% as carbohydrates on average, in order to provide all study participants with approximately 1,000 calories daily for 2 months.

The prescribed diet included breakfast consisting of 2 boiled eggs (80 calories), 50 g cheese (100 calories), and 1 slice of bread (105 calories); and lunch consisting of 2 pieces (100 g) of boiled meat (240 calories) or chicken (300 calories), 500 g salad (105 calorie), 300 g boiled vegetables (110 calories), and 100 g banana (100 calories). However, the dinner consisted of only 200 g skimmed milk (120 calories). We checked that the food was eaten as 3 daily meals, and we emphasized the need to have a substantial breakfast. The two groups underwent an identical dietary monitoring program with an initial consultation, and with one check-up in the middle of the program and another during the final sessions by a dietician who was blinded to the type of program the subject had followed. The mean values of SBP, DBP, HR, MVV, myocardial oxygen consumption, and BMI were obtained for both groups before and after the exercise program.

RESULTS

Forty obese subjects, whose ages ranged from 18 to 25 years, were divided into 2 equal groups: group A received aerobic exercise training for 3 months in addition to dietary measures, and group B received anaerobic exercise training for 3 months in addition to dietary measures. The mean BMI, SBP, DBP, and HR values were significantly decreased, whereas the mean MVV and VO_2 max values were significantly increased in group A after treatment. The mean BMI, SBP, DBP, HR, and VO_2 max values not show a significant change, and the mean MVV values were significantly increased in group B after treatment (Tables 1–3).

DISCUSSION

In this study, a significant reduction in BMI was observed in the aerobic exercise group. This result is supported by

Table 1. Mean values and significance of measured parameters before and after treatment in group A

Item		BMI (kg/m^2)	SBP (mmHg)	DBP (mmHg)	HR (beats/min)	MVV (L/min)	VO_2 max. (L/min/Kg)
Mean±SD	Before	36.45±3.36	136±5.9	87.5±4.4	82.1±2.7	96.2±10.8	3.35±0.64
	After	30.01±2.56	124.5±6.8	80.1±5.02	74.3±3.8	126.6±16.6	3.92±0.53

SBP: systolic blood pressure, DBP: diastolic blood pressure, HR: heart rate, MVV: maximum voluntary ventilation, BMI: body mass index, VO_2 max.: maximal oxygen consumption

Table 2. Mean values and significance of measured parameters before and after treatment in group B

Item		BMI (kg/m^2)	SBP (mmHg)	DBP (mmHg)	HR (beats/min)	MVV (L/min)	VO_2 max (L/min/kg)
Mean±SD	Before	35.95±3.72	136.5±4.8	88±4.1	81.6±3.6	98.02±7.7	3.42±0.75
	After	33.54±2.26	136.4±5.8	88.5±3.6	82±4.6	104.4±11.9	3.61±0.82

SBP: systolic blood pressure, DBP: diastolic blood pressure, HR: heart rate, MVV: maximum voluntary ventilation, BMI: body mass index, VO_2 max: maximal oxygen consumption

Table 3. Comparison of mean values and significance of measured parameters after treatment between groups

Item		BMI (kg/m^2)	SBP (mmHg)	DBP (mmHg)	HR (beats/min)	MVV (L/min)	VO_2 max (L/min/kg)
Mean±SD	Group (A)	30.01±2.56	124.5±6.8	80.1±5.02	74.3±3.8	126.6±16.6	3.92±0.53
	Group (B)	33.54±2.26	136.5±5.8	88.5±3.6	82±4.6	104.4±11.9	3.61±0.82

SBP: systolic blood pressure, DBP: diastolic blood pressure, HR: heart rate, MVV: maximum voluntary ventilation, BMI: body mass index, VO_2 max: maximal oxygen consumption

previous studies that have reported a significant reduction in BMI with aerobic exercise, which is associated with subsequent cardiovascular risk factors; this reduction therefore decreases the risk of cardiovascular disease in these subjects[13, 14].

The results also indicated that there was a significant increase in MVV in both the aerobic exercise group and the anaerobic exercise group, where the aerobic exercise group obtained a greater increase in MVV than the anaerobic exercise group. This result is supported by a previous study that 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[15]. This result was also supported by a study comparing cardiopulmonary function between a moderate exercise program and a severe exercise program; a significant improvement in VO_2 max and MVV was reported after both types of exercise[16]. The results also indicated that there was a significant reduction in HR, SBP, and DBP at the end of the program in the aerobic exercise group.

Regular aerobic training induces significant adaptations both at rest and during maximum exercise in a variety of dimensional and functional capacities related to the cardiovascular and respiratory regulation system, thus enhancing the delivery of oxygen to the active muscles. These changes include decreases in resting and maximal exercise HR and enhanced stroke volume as well as cardiac output[17, 18]. The reduction of HR, SBP, and DBP 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[19].

The results of our study also indicated that there were no significant changes in HR or in SBP and DBP in the anaerobic exercise group after completion of anaerobic exercise program, but there was a significant reduction after the aerobic exercise program. This reflects an increased cardiorespiratory load related to the increased duration of the training session from 20 to 30 minutes. However, the greater blood flow under the influence of the rise in HR and SBP does not satisfy the increased oxygen requirements during anaerobic exercise. This explains the significant augmentation of pulmonary ventilation and ventilation capacity in the attempt to satisfy the expanding oxygen transport requirements during maximal exercise. Participation in heavy resistance anaerobic training over an extended period of time increases cardiac workload, and thus it could not be sustained over an extended period of time[20].

The results concerning myocardial oxygen consumption in our study indicated that there were no significant changes in myocardial oxygen consumption after completion of the anaerobic exercise program. However, there was a significant reduction after the aerobic exercise program. The improvements in the resting HR and SBP are reflected in the myocardial oxygen consumption in this study. This improvement in myocardial oxygen consumption might be due to an improvement in endothelium–dependent vasodilatation in both epicardial coronary vessels. Additionally, it might be due to the recruitment of coronary collateral vessels and enhanced blood flow with regulation of the vasomotor tone toward vagal modulation. The myocardial oxygen consumption was lowered after 8 weeks of the training program from 60% to 80% of HRmax. This improvement might be due to increased peripheral vasodilatation and consequently, a decreased afterload following exercise and a reduction in the adrenergic efferent stimuli[21, 22]. Aerobic exercise improves cardiorespiratory fitness in obese subjects with less cardiac workload as evidenced by the low myocardial oxygen consumption, while anaerobic exercise increases cardiac work and is difficult to maintain for extended periods of time[23–26], 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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