Research Article

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Ventilatory response to aerobic exercise in obese children.

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This study was conducted at the Faculty of Physical Therapy, Cairo University, Egypt in 2010, to examine the effects of aerobic exercise in ventilatory functions in obese children. Forty obese children and 20 age and sex matched non obese control group were studied. Their age was ranging from 10 to 14 years. They were randomly assigned to study and control group. A child with a body mass index (BMI) in the 95th percentile or greater was considered to be obese. The study group (A) received aerobic exercise training on treadmill while children in the control group (B) did not participate in any intervention for 3 months. Pulmonary function test (FVC, FEV1, FEV1/FVC, MMEFR, and MBC) was used to measure lung functions in all children pre and post treatment. The results of this study revealed no significant difference was recorded between the two groups before treatment. While after 3 months, significant improvement was recorded in the two groups. There was also significant difference between the two groups in favor of the study group. From the obtained results, it can be concluded that, aerobic exercise training program had positive effects on lung functions in obese children.

Key words: ***Ventilatory Response, Aerobic Exercise, Obese Children*.**

Obesity is a frequent pathology with a multitude of complications; over the last few decades, it has become an increasingly significant public health concern in both developed and developing countries (Albright et al., 2000).

Obesity in childhood has therefore become a health issue of concern to health professionals throughout the world as a leading factor for certain chronic diseases such as hyperlipidemia, hyperinsulinemia, hypertension, and early atherosclerosis. Whether it persists or not in adulthood, childhood obesity is substantially related with increased morbidity and mortality (Dietz, 1998).

However, the detection of obesity during childhood is more difficult than during adulthood due to the developmental changes in children. Additionally, there is no general consensus on the reliability, use, application of direct and indirect anthropometric indices describing obesity in children (De Onis, 2004).

Fundamentally, the etiology of overweight in children and adolescents, as in adults, is attributable to energy (caloric) intake in excess of energy expenditure. Genetic, environmental, socio-cultural, and family characteristics have been identified as key influences on energy expenditure and dietary intake, and subsequent overweight prevalence (Dietz and Gortmaker, 2001).

In adults as well as in children and adolescents, the influence of obesity on lung function at rest is well documented in terms of increased airway hyperresponsiveness (AHR), decreased forced vital capacity (FVC), forced expiratory volume (FEV1), and peak expiratory flow (PEF)(Ulger et al.,2006).

Treatment programs for childhood obesity require a multi-disciplinary approach, and should include dietary changes, nutritional education, changes in physical activity patterns and behavioral modification (Goran et al., 1999). Walking and running are convenient and beneficial exercise modes to improve energy balance, aerobic fitness, metabolic fitness, and general well being in obese children and adolescents (Blair and Church, 2004).

The major effects of aerobic exercises are the enhancing of breathing efficiency and to decrease pulmonary resistance. Increase in physical exercise, on the other hand, could help increase in pulmonary function and decrease in fat percentage (Kippelen, 2005). Aerobic exercise also decreases subclinical, chronic inflammation and improves endothelial function simply as a result of reducing obesity (particularly visceral obesity) and improving insulin sensitivity (Zoppini et al., 2006).

MATERIALS AND METHODS

Subjects:

Forty obese children and age and sex matched 20 non obese children were evaluated as control group. Their age was ranging from 10 to 14 years. The children were recruited from the Out-patient Clinic at the Faculty of Physical Therapy, Cairo University, Egypt.

Children with significant health problems (e.g. cardiovascular disease, diabetes, orthopedic limitations etc.) or medication that could affect the results of the study or preclude their safe participation were excluded. All subjects provided an informed consent including their parent's testimonial. This study was approved by the ethical committee of the Faculty of Physical Therapy, Cairo University. The patients equally and randomly divided into control and study groups. Evaluation was carried out for all patients, before and at the end of the treatment program.

Evaluation:

1- Anthropometry:

Child height without shoes was measured to the nearest 0.1 cm using a standard meter. Body weight was measured using standard calibrated clinical weight scale in light indoor clothes to the nearest 0.1 kg. Body mass index (BMI) was calculated as the weight (kg) divided by the height squared (m^2). Being overweight was defined as having BMI more than 85^{th} and less than 95^{th} percentile of BMI for age and sex (American Diabetes Association, 2010).

2- Ventilatory function test :

Spirometer (Schiler-Spirovit SP-10) was used to measure lung function testing, including forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), FEV1/FVC ratio, maximum mid-expiratory flow rate (MMEFR) and maximum breathing capacity (MBC), obtained from all children participated in the study. These respiratory function tests were performed by the same therapist. After all connections and parts well secured and fitted in place; the child was then connected to a flow sensor through a mouth piece while seated on a chair of suitable height. The mouth piece was held by child teeth and enclosed firmly by his lips, nasal clips were also used. Each procedure was repeated 3 times with rest in between and the maximal value of each was recorded. These spirometric parameters were calculated and analyzed by a computerized spirometer which is calibrated every morning.

3- Cardiopulmonary exercise test procedure (CPET):

After the child become familiar with the equipment; each child underwent continuous exercise tolerance test (according to Bruce protocol) consisted of warming up, 4 phases in which children were encouraged verbally to do their best effort, and recovery phase. The following data were recorded: maximal oxygen consumption ($VO_{2\ max}$, ml/min/kg and % of predicted value) anaerobic threshold (AT, % of $VO_{2\ max}$), and the maximum heart rate.

Treatment:

Children of the study group (A) received aerobic exercise training in treadmill while children in the control group (B) did not participate in any intervention and was asked to maintain the current level of physical activity during the 3 months.

Aerobic Exercise Interventions:

The majority of studies in childhood and adolescent obesity have focused on aerobic exercise, designed primarily to increase caloric expenditure. Aerobic exercise consists of repetitive large muscle group exercise such as walking on treadmill.

The aerobic treadmill-based training program (PRECOR 9.1/9.2, China) was set to 60% of the maximum heart rate (HR_{max}) achieved according to a modified Bruce protocol. This rate was defined as the training heart rate (THR). After an initial, 5-minute warm-up phase performed on the treadmill at a low load, each endurance training session lasted 40 minutes and ended with 5-minute recovery and relaxation phase.

The 3-month intervention aerobic exercises were conducted 5 times/week/50-min session (walking on treadmill) supervised by qualified physiotherapists without any dietary intervention. Exercises were progressively intensified as individually tolerated. There was one consultation with a nutritionist to enhance knowledge about healthy nutrition for children of both groups. There was no change in calorie intake or diet plan in both groups (Robergs and Landwehr, 2002).

Statistical analysis:

The collected data of demographic and other baseline characteristics was statistically treated to show mean and standard deviation of mean for age, height and weight. The collected data for both groups were statistically analyzed using SPSS version 16.0. Paired and un-paired t-test was conducted for ventilatory functions to determine any statistically significant differences between data collected before and after treatment within each group and between groups respectively. P-value (<0.05) was considered significant.

RESULTS

The collected data of the current study was statistically analyzed to examine the effects of aerobic exercise in ventilatory functions in obese children. Forty obese children and 20 age and sex matched non obese control group were studied. They were randomized divided into two equal groups; aerobic exercise group (A) performed aerobic training program for 12 weeks, and control group (B) didn't receive any training for 12 weeks.

Table (1) show the mean, standard deviation, maximum and minimum of the age, height, weight and body mass index of the three groups (A, B and C) (pre-test values). The two groups were matched for age and height and BMI with the C normal group.

There were no statistically significant differences between the A, B and C groups regarding the pre study measured age and height variables; $P>0.05$ where there were statistically significant differences between the A, B and C groups regarding the pre study measured weight variable; $P < 0.05$.

The results in Table (2) show that there is no significant difference between study and control groups at the beginning of research, but considering the study result using independent t-test followed by 3-months exercise show that a significant difference (p-value $\leq$ 0.05) was observed in the study group.

The results show that there is significant difference between study and control groups after treatment in FVC, FEV1, MMEFR values, which show a significant difference (p-value $\leq$ 0.05) was observed in the study group. Also the results show that there is significant difference between study and control groups after treatment in, FEV1/ FVC, MBC values, which show a significant difference (p-value $\leq$ 0.05) was observed in the study group as shown in figure (1).

DISCUSSION

Studies evaluating the effect of overweight on pulmonary function have produced variable results. This may be because of different criteria for measuring obesity, numbers of subjects, and different degrees of obesity. The current study found evidence that aerobic exercises training may positively affect body composition through a reduction in body fat.

Many of these studies have not included an obese control group, and most have not comprehensively examined the independent effect of exercise training alone, using a randomized controlled design or sophisticated measures of body composition change. Notwithstanding these limitations, the well controlled studies that employed appropriate measures of body composition suggest that exercise, as an independent intervention, is associated with beneficial adaptations in body composition. Aerobic exercises may decrease body fat, increase lean body mass and have minimal impact on gross measures such as bodyweight and BMI.

Obesity can profoundly alter pulmonary function and diminish exercise capacity by its adverse effects on respiratory mechanics, resistance within the respiratory system, respiratory muscle function, lung volumes,

Table 1: Physical characteristics for children of the three groups

	Obese Children		Non Obese Children
Character	**Study group (A)**	**Control group (B)**	**Matched group (C)**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**
Age (Yrs.)	11.9 ± 1.2	12.1 ± 1.13	12 ± 1.2
Height (Cm)	148.95 ± 11.98	150.05 ± 11.38	148.5 ± 13.9
Weight (Kg)	58.32 ± 10.3	59.33 ± 10.57	44.43 ± 1.2
BMI (kg/m^2)	25.99 ± 0.77	26.13 ± 0.81	19.71 ± 2.14

work and energy cost of breathing, control of breathing, and gas exchange (Goran et al., 1999).

Generally, in mild obesity, spirometry is normal. As BMI increases (particularly in morbidly obese individuals) there is evidence of a reduction in expiratory flow and a decrease in FEV1 and forced vital capacity (FVC) (Topp et al., 2009). In a study by (Sahebjami and Garside, 1996), reductions in FEV1, FVC and maximal inspiratory flow rate in obese subjects were associated with a low MVV. Both FEV1 and FVC were similarly reduced (in terms of percentage predicted), the FEV1 to FVC ratio was normal and static lung volumes were reduced, suggesting the reduction may be due to restriction as opposed to air flow obstruction.

Lazarus et al., (1997), found that the FEV1 to FVC ratio decreases with increasing BMI in overweight and obese individuals. In morbidly obese subjects (defined as individuals with a body weight (in kilograms) to height (in centimeters) ratio greater than 0.9 kg/cm), Biring et al., (1999), found a reduction in midexpiratory flows and the FEV1 to FVC ratio. Therefore, it appears that spirometric abnormalities in patients with mild to moderate obesity represent a restrictive defect placed on the system whereas with severe and morbid obesity, it represents true air flow obstruction. The mechanism may be related to small airway collapse due to decreased lung volumes with increasing obesity or it may be independent.

Because most of the respiratory function abnormalities seen in obesity are due to the mechanical load of adipose tissue on the chest wall and resultant deconditioning, it would be expected that a reduction in weight would lead to improvement in many of these physiological derangements.

Aerobic exercise, designed primarily to increase caloric expenditure. Studies in adults suggest that whilst exhibiting an inconsistent effect on body composition and skeletal muscle mass and strength, aerobic exercise is associated with improvement in maximal oxygen consumption (VO_{2max}) and cardiovascular fitness (Pollock et al., 1998).

Aerobic exercise is also associated with eccentric cardiac hypertrophy, increased cardiac chamber dimensions, enhanced skeletal muscle capillary density and, at a cellular level, upregulation of aerobic enzyme concentrations and mitochondrial density (McArdle et al., 1996). However, the majorities of studies investigating the effects of aerobic exercise training in childhood obesity have been poorly controlled and have not

Figure 1: Post treatment mean values of all measured variables of study (A) and control (B) groups.

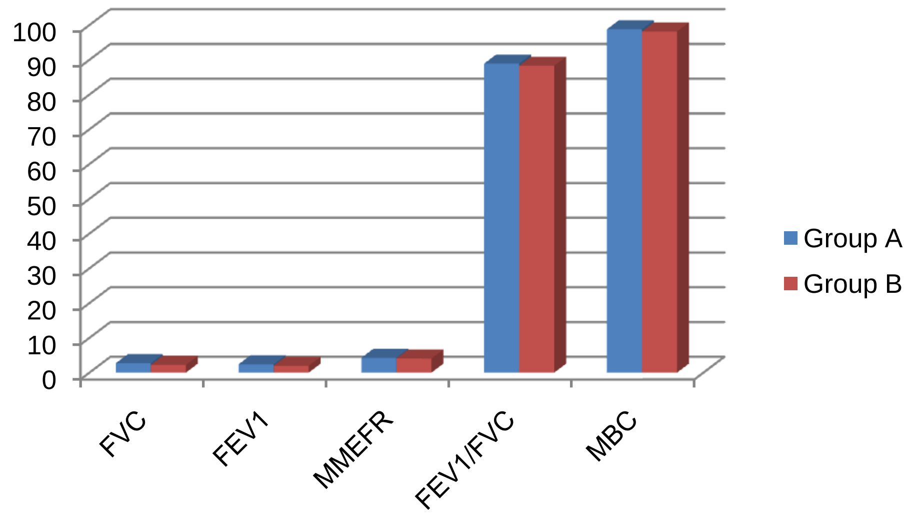

Table 2: Pre and post test values (FVC, FEV1, FEV1/FVC, MMEFR, and MBC) for both groups

Groups	Study Group (A)		Control Group (B)	
Values	**Pre Test**	**Post Test**	**Pre Test**	**Post Test**
FVC	2.17 ± 0.57	2.7± 0.66	2.21 ± 0.58	2.23 ± 0.58
FEV1	1.92 ± 0.48	2.39 ± 0.6	1.95 ± 0.48	1.96 ± 0.46
FEV1 / FVC	89.72 ± 3.64	88. 91 ± 4. 3	88.51 ± 5.63	88.29 ± 5.63
MMEFR	4.1 ± 0.55	4.26 ± 0.58	4.06 ± 0.49	4.06 ± 0.56
MBC	96.23 ±14.75	98.79 ± 14.39	98.33±14.63	98.16 ± 14.12

specifically stratified the independent effect of exercise versus dietary modification (Rocchini et al., 1998).

The results of this study indicated that weight reduction improves ventilatory functions in obese children with bronchial asthma; these findings are agreed and supported with many previous studies as, Hakala et al.,(2000) , reported reductions in airway obstruction in obese asthmatics who underwent an 8-week very low calorie diet that resulted in about 14% reduction in body and was associated with increases in peak expiratory flow (PEF), FEV1 and FVC and reductions in dyspnea score and use of rescue medications (Aaron et al.,2004).

Conclusions

In conclusion, we found pulmonary abnormalities to be common among obese children, and that reduction in static lung volumes were found to be significantly correlated with the degree of obesity. The clinical significance of such a finding in this group of asymptomatic obese children remains unknown. It is important to assess the longitudinal changes and tracking into adulthood of such abnormalities in order to provide appropriate management. Aerobic exercise had significant effect on lung functions in obese children. However further research is required to determine whether trachea indexes could be increased by combining training and diet regimen.

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