Efficacy of Weight Reduction on Selected Ventilatory Functions in Obese Girls
Sally E. Ragheb, Akram A. Sayed, Samah M. Ismail, Gamal A. Yamamah

ABSTRACT
Background: Obesity is one of the biggest public health problems worldwide. It currently affects all age groups, including children and adolescents. Fat tissue accumulation impairs ventilatory function in adults and children.

Objective: The purpose of this study was to find out the efficacy of weight reduction on selected pulmonary functions in obese girls.

Methods and Material: Thirty obese girls were recruited for the study, their age ranged from 12 to 15 years with mean value of 13.87 ± 1.22 years. They were selected randomly from Dar El-Salam General Hospital based on the inclusion criteria. They performed Aerobic exercise program 3 times per week in addition to diet modification for 12 weeks.

Results: Our program of weight reduction lead to significant decrease in weight and BMI by 2.66% and 4.09% respectively (p< 0.001). Pulmonary functions test showed significant improvement of VC, FVC, FEF25%-75%, Best FVC and Best FEV1 by 53.68%, 41.37%, 205.34%, 113.25% and 101.71% respectively (p< 0.001).

Conclusion: We concluded that studied ventilatory functions were improved for all girls in response to our weight reduction program.

Key words: Obesity, Weight reduction, pulmonary function tests, Children.
INTRODUCTION

Obesity is one of the biggest public health problems worldwide. It currently affects all age groups, including children and adolescents. The World Health Organization (WHO) characterizes the fight against obesity as one of the primary challenges for healthcare professionals in the 21st century. In Brazil, the prevalence of obesity is greater than 30% among children between 5 and 9 years of age and is almost 20% in children between 10 and 19 years of age. About 20 percent of Egyptian preschoolers were overweight or obese in 2008.

Obesity, defined as excessive fat tissue, contributes to the development of several systemic diseases and higher mortality. Physical activity reduces the harm caused by obesity, which improves patients’ metabolic profiles and prevents obesity’s deleterious structural and psychosocial effects. Additionally, daily exercise improves quality of life. The number of obese children has increased significantly, which predisposes them to the same changes in respiratory mechanics as adults.

Of all those affected, the respiratory system deserves special attention because obesity promotes important changes in its mechanics, in tolerance to exercise, gas exchanges, control of the respiratory pattern and the strength and endurance of respiratory muscles.

In childhood, it is difficult to evaluate obesity because of the intense rate of change of body structures during growth, and there is not universally accepted system to classify childhood obesity. However, the World Health Organization (WHO) takes into consideration the distribution of the weight/height Z score, which is the ratio of weight measured and ideal weight for height, that is, the body mass index (BMI) is used.

Methods and Materials

Approval of faculty of physical therapy ethical committee was obtained in 10-11-2015 and approval of Cairo University ethical committee was obtained in 16-11-2015. Children parents were informed about the nature of the study protocol before the initial assessment; they signed informed consent form before they their children participate in this study.

Study design: Cohort prospective study was designed to evaluate comprehensive program for weight reduction including exercise and diet regimen and evaluating their effects on some pulmonary functions.

Subjects:

Thirty female obese children were recruited for this study from outpatient clinic of Dar El-Salam General Hospital, the study was conducted at physical therapy department in Dar El-Salam General Hospital, Cairo. They were selected to fulfill inclusion criteria of the study

Inclusion Criteria:

- Female
- Age ranged from 12 to 15 years old
- Class 1 obesity, Body mass index (BMI) >= 30 - 34.9kg/m²
- Obesity limited to behavioral and environmental factors (sedentary lifestyles combined with excess energy intake)
- Free from any acute or chronic disease
Exclusion Criteria
- Male
- Age < 12 or > 15 years old
- Body mass index (BMI) >= 40 kg/m² or < 30
- Non nutritional obesity (hormonal factors or syndromes)
- Children who had cerebrovascular, cardiovascular diseases
- Chronic (respiratory, kidney, liver, metabolic and neurological) disorders and Anemia or hypothyroidism
- Musculoskeletal conditions that restrict their physical activity

Subjects in the study were subjected to the following:
1- Thorough clinical history taking and clinical examination to confirm presence of all inclusion criteria
2- Pulmonary function testing using Spirometer: (Spirolab3, MIR009, Italy), Computerized instrument that record most of the lung volumes, capacities and flow rates.

Measurements obtained from the spirometer are Forced vital capacity (FVC), Forced expiratory volume in the first second (FEV1), Average flow between 25% and 75% of the FVC (FEF25-75%), Best Forced vital capacity (Best FVC) and Best Forced expiratory volume (Best FEV)

Spirometry test: technique is similar in adults and children aged ≥6 years. The test was performed by trained person. Equipment was calibrated and the procedure was explained to the patient in a friendly way.

Children were asked if they have recently taken any medications such as bronchodilators or β-blockers, when they last had a meal (as heavy meals can affect performance of the test, possibly causing some restriction), and they were advised not to wear tight or restrictive clothes that could interfere with the test.

The subject’s weight and height was measured and entered into software along with the name, ID, age, sex, and race. Subjects performed the test in standing position. A new disposable mouthpiece was attached to the spirometer and a nose clip was used.

3- Anthropometric measurements:
   a- Tape measurement: Non stretchable tape was used to measure both hip and waist circumferences. Waist circumference was measures at the level of umbilicus while subject is at mid breathing state. Hip circumference was measured by applying tape at the largest contour and passing by symphysis pubis. Waist hip ratio was calculated according to the following formula: waist circumference (cm)/hip circumference (cm).

   b- Weight and height scale; Secca Balance and Scale Apparatus (Germany) was used for measuring the weight to the nearest 0.01Kg and height to the nearest 0.1 cm. Body mass index (BMI) was calculated according to the following formula: BMI= Weight (kg)/Height (m²).
4- **Intervention weight reduction program for 12 weeks.** It included aerobic exercise and diet modification programs.

**a- Aerobic exercise program:**
Children performed aerobic exercise on a treadmill for 30 minutes under supervision. There were 5 minutes for warming-up before starting and another 5 minutes for cooling-down after finishing in the form of light aerobic exercise. Treadmill (Enraf Nonius, EN-TRE, Germany) was used for training program of the children. Its speed, inclination and timer are adjustable, and it also provided with control panel to display the exercise parameters. Each child performed exercise training at moderate intensity (12-14 on the Borg scale) which means that the subject feels tired but can continue (Borg, 1998). Ratings of perceived exertion are generally believe to be valid and reliable markers of physiological intensity during exercise and were recommended to monitor exercise intensity (Janice et al., 2002).

**b- Diet modification program:**
For each subject, a diet program was prepared according to Estimated Energy Requirement (EER) calculations and physical activity. For 3-18 years (female) the formula is: 
\[
\text{EER} = 389 - [41.2 \times \text{age (y)}] + 15.0 \times \text{weight (kg)} + 701.6 \times \text{height (m)}.
\]

PA = physical Activity

- Sedentary (1.00)
- Low active (1.18)
- Active (1.35)
- Very active (1.60)

Diets high in fat and energy have been found to contribute to overweight and obesity.

The American Academy of Pediatrics (AAP) recommendations to reduce children's dietary fat intake were accompanied by suggestions that fat calories should be replaced by eating more grain products, fruits, vegetables, low fat dairy products, beans, lean meat, poultry, fish, and other protein rich foods. Children were advised to meet the recommendation to lower fat intake by consuming a wide variety of foods from all the food groups, and consuming adequate energy to maintain healthy body weight. Lower fat diets may be attained via these substitutions across food groups.

5- **Pulmonary function testing.** And anthropometric measurements were done for follow up after 3 months of the diet reduction program.

6- **Statistical analysis.** In this study the mean, the standard deviation were calculated to determine Weight, Height, Body mass index, Waist hip ratio and Ventilatory function measurements for all children. Paired t-test was used to compare pretest and posttest mean scores for all children.

**RESULTS:**
Girls' age in the study ranged from 12 to 15 years old with mean value of (13.87 ±1.22) years.
Table 1: Anthropometric data of the study subjects

| Item          | Anthropometric measure | Pre intervention | Post intervention | Mean difference | % change | P-value |
|---------------|-------------------------|------------------|-------------------|----------------|----------|---------|
| Weight (Kg)   |                         |                  |                   |                |          |         |
| Range         | 51.00– 98.50            | 48.00 – 95.00    | 2.16              | - 2.66%        | 0.0001   |
| Mean± SD      | 81.32 ±9.93             | 79.16 ±9.69      |                   |                |          |         |
| Height (cm)   |                         |                  |                   |                |          |         |
| Range         | 130.0 – 168.0           | 131.0 – 168.0    | 0.67              | 0.43%          | 0.086    |
| Mean± SD      | 157.53 ±7.15            | 158.20 ±6.77     |                   |                |          |         |
| BMI (kg/ m²)  |                         |                  |                   |                |          |         |
| Range         | 30.06 – 34.96           | 27.05 – 34.16    | 1.34              | - 4.09%        | 0.0001   |
| Mean± SD      | 32.78 ±1.83             | 31.44 ±2.13      |                   |                |          |         |
| Waist/Hip ratio |                       |                  |                   |                |          |         |
| Range         | 0.73 – 0.91             | 0.55 – 0.90      | 0.18              | - 1.20%        | 0.333    |
| Mean± SD      | 0.83 ±0.06              | 0.82 ±0.07       |                   |                |          |         |

Table 2: Percentage values of pulmonary function data of the study subjects

| Item          | pulmonary function data | Pre | Post | Mean difference | % change | P-value |
|---------------|-------------------------|-----|------|-----------------|----------|---------|
| Vital capacity|                         |     |      |                 |          |         |
| Range         | 13.00 – 137.00          | 36.10 – 144.40 | 32.81 | 53.68%          | 0.001    |
| Mean± SD      | 61.12 ±31.15            | 93.93 ±18.21   |                   |          |         |
| Forced Vital Capacity |                       |     |      |                 |          |         |
| Range         | 15.00 – 96.00           | 41.80 – 93.10  | 19.96 | 41.37%          | 0.007    |
| Mean± SD      | 48.25 ±26.38            | 68.21 ±13.10   |                   |          |         |
| FEF25-75%     |                         |     |      |                 |          |         |
| Range         | 67.00 – 114.00          | 14.00 – 106.00 | 34.97 | 205.34%         | 0.0001   |
| Mean± SD      | 17.03 ±41.81            | 52.00 ±21.60   |                   |          |         |
| Best FVC      |                         |     |      |                 |          |         |
| Range         | 10.00 – 73.00           | 42.00 – 88.00  | 31.29 | 113.25%         | 0.0001   |
| Mean± SD      | 27.63 ±28.76            | 58.92 ±12.05   |                   |          |         |
| Best FEV1     |                         |     |      |                 |          |         |
| Range         | 10.00 – 79.00           | 32.00 – 93.00  | 29.77 | 101.71%         | 0.0001   |
| Mean± SD      | 29.27 ±30.57            | 59.04 ±13.42   |                   |          |         |
DISCUSSION
This study was conducted to find out the effect of weight reduction on selected pulmonary functions in obese female children.
Statistical analysis showed that there was significant decrease in weight and BMI by 2.66% - 4.09% respectively and improvement of pulmonary functions tests (VC, FVC, FEV25%-75%, Best FVC and Best FEV1) by 53.68%, 41.37%, 205.34%, 113.25% and 101.71% respectively; after applying our weight reduction program.
There was significant improvement in pulmonary functions test after weight loss by Diet modification program and aerobic exercise performed on a treadmill for 30 minutes.
Respiratory function is affected in obese children due to changes in the mechanics of respiratory muscles that expand the thorax and in lung compliance and resistance, which may lead to rapid, shallow breathing, increased work of breathing and reduced maximal ventilatory capacity.
Current study was supported by findings of Santiago SQ et al. According to ventilatory mechanics and pulmonary function, this accumulation of fat may lead to dysfunctions of the several structures that make up the respiratory system, particularly the muscles that take part in breathing. This may lead to changes in pulmonary functions due to the increase in respiratory effort and the compromise of gas transport.
Teixeira et al (2001) found that the respiratory system deserves special attention because obesity promotes important changes in its mechanics, in tolerance to exercise, gas exchanges, control of the respiratory pattern and the strength and endurance of respiratory muscles.

In contrast, Lean ME, et al who suggested that studies found that obesity at a low level has little effect on pulmonary function.

Another study of Speiser P, et al suggested that In childhood, it is difficult to evaluate obesity because of the intense rate of change of body structures during growth, and there is not universally accepted system to classify childhood obesity. However, the World Health Organization (WHO) takes into consideration the distribution of the weight/height Z score, which is the ratio of weight measured and ideal weight for height, that is, the body mass index (BMI) is used. (Mandy et al., 2013) suggested that the importance of dietary interventions as an essential component for managing childhood obesity and providing insights into the impact of different exercise modalities on weight loss and metabolic risk reduction. Dietary interventions in conjunction with exercise interventions are effective in reducing metabolic risks, particularly HDL-C and fasting insulin levels.

CONCLUSION
Based on the findings of this study, we could conclude that there was significant improvement in ventilatory function measure elements for all studied girls in response to weight reduction.

CONFLICT OF INTEREST
No conflict of interest

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