Leptin and ventilatory function response to exercise in obese boys and girls: A comparative study.

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Abstract: This study was an attempt to determine and compare difference in response of serum leptin and ventilatory function (including forced vital capacity "FVC" and forced expiratory volume in the first second "FEV1") in obese boys and obese girls to aerobic exercise. Subjects: 40 obese child (body mass index (BMI)) in the 95th percentile or greater) with age range of 10 to 13 years were into the study. They were divided into two groups of equal number, 20 obese boys (Group A) and 20 obese girls (Group B). Methods: Both groups received moderate intensity aerobic exercise training on a stationary bicycle ergometer for 3 months; 5 days per week. Serum leptin level and ventilatory function (FVC and FEV_1) were assessed in all children before beginning and after finishing the study. Results: After 3 months of aerobic exercise training; There were significant reduction in serum leptin and significant increase in ventilatory function in both obese boys and obese girls groups. Furthermore; there was significant difference between both groups in serum leptin in favor of group B. In the contrary; there was significant difference between both groups in ventilatory function in favor of group A. Conclusion: after aerobic training; ventilatory functions respond in obese boys more favorably than in obese girls. In the contrary; serum leptin respond in obese girls more favorably than in obese boys.

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1. Introduction:

Pediatric obesity has become a problem of epidemic proportions. Because it is becoming worse each year, childhood obesity has been expressed as one of the greatest neglected public health problems of all ages that harm our life.[1] Childhood obesity is actually a distressful public health problem. In the year 2000; the International Obesity Task Force estimated that about 10% of children aged 5 to 17 years were overweight, among which 2% to 3% were obese. This corresponded to 155 million overweight and 30 to 45 million obese children worldwide.[2] The rising childhood obesity problem is of great importance since obesity is a highly public health pandemic manifesting itself in premature death, multiple comorbid disabilities and exaggerated health care costs.[3] Childhood obesity problem is of great importance because it is associated with serious conditions, such as coronary heart disease, raised blood lipid profiles, chronic respiratory conditions, type 2 diabetes and sleep apnea.[4] The main cause of overweight in children and adolescents as well as adults is excess Energy (caloric) intake when compared to energy expenditure. Genetic, environmental, socio-cultural, and family characteristics are factors identified as key influences on dietary intake and energy expenditure and subsequent overweight prevalence.[5]

Leptin is an adipose tissue product and present in higher concentrations in blood of obese adults, adolescent and children than of lean subjects. Normally leptin producing its action through appetite reduction and increasing energy expenditure.[6-7] Plasma leptin levels have a strong positive association with total body fat and other markers for obesity such as BMI, and girls had higher leptin concentrations than boys.[8] Althought it is expected that high leptin concentrations would reduce energy intake in obese children, but actually the obese children energy intake levels are higher than the lean children, that may be called leptin resistance.[9]

Also it is well documented that pulmonary abnormalities are common among obese children, and that reduction in static lung volumes was found to be significantly correlated with the degree of obesity.[10] Child as well as adult obesity influence lung function at rest as well as during activity. Obesity increases airway hyperresponsiveness (AHR), decreases forced vital capacity (FVC), forced expiratory volume (FEV_1), and peak expiratory flow (PEF).[11] Obesity has various deleterious effects on respiratory function. Respiratory muscle strength, endurance, pulmonary

gas exchange, control of breathing are all lower and disrupted in obese children. Obesity also cause limitations in pulmonary function tests and exercise capacity.[12] Alterations in respiratory mechanics caused by obesity, may be also due to probable lung compression.[13]

Physical activity is an integral part of the childhood obesity management and should be individually adjusted according to the degree of obesity, age, and presence of comorbidities. Physical activity does not only increase energy expenditure and fat loss, but also it protects against the lean body mass loss, improves cardiorespiratory fitness, reduces obesity-related cardio-metabolic health risks, and evokes sensations of well-being.[14] Leptin can be thought as to be adipose tissue as well as activity dependent. Leptin is negatively associated with respiratory indices (FEV_1) and physical activity in obese children.[15] Leptin concentration decreased during physical training and increased without physical training in obese children, with a greater reduction occurs in children with higher pre-training leptin concentration.[16] Childhood obesity impairs FVC and FEV_1. Appropriate aerobic exercise training improves FVC and FEV_1 in obese children and enhances the respiratory muscle performance.[17]

Although many studies have been published on the effects of exercise on leptin, numerous questions remain to be answered. No study defined the relation of adiposity in both genders to leptin responses and adaptations to exercise.[18] It was clear that a number of studies discussed the effect of exercise on obesity related changes in obese children, but - up to our knowledge and available literature - none of them explored or compared the gender related response of leptin and ventilatory function to exercise in obese boys and girls on a separate basis. So, the purpose of the present study was to determine and compare gender related response of serum leptin and ventilatory function to aerobic exercise in obese boys and girls. The measures in this study were serum leptin, FVC, and FEV1.

2. Subjects and Methods

Forty obese (BMI $\geq$ 95th percentile), non-asthmatic; non-diabetic children were enrolled into and completed the study. Their age ranged from 10 to 13 years. They were assigned according to their gender into two groups; 20 obese boys (Group A) and 20 obese girls (Group B). All children were recruited from Kasr Al-Aini hospital, pediatrics outpatient clinics, Cairo University, Egypt. Children with significant health problems or medication that could affect the results of the study or affect their safe participation were excluded. Informed consents from all children and their parents were obtained at the beginning of the assessment. Evaluation was carried out for all children, before and at the end of the training program.

Chemical analysis:

Leptin levels were determined with ELISA (enzyme-linked immunosorbent assay) method using DRG Leptin (sandwich) ELISA EIA-2395 kit Germany. A blood sample was taken from each child in a clean tube containing K2EDTA and centrifuged, then plasma was separated and stored frozen at -20^{O}C.[19]

Ventilatory function evaluation:

Ventilatory function (FVC and FEV_1) were measured for all participating children using computerized **(Schiler-Spirovit SP-10)** spirometer by the same team according to the recommended standards.[20] The best of at least three technically acceptable values for FVC and FEV_1 were selected.

Body mass index evaluation:

Body weight was measured in light indoor clothes to the nearest 0.1 kg and child standing height without shoes was measured to the nearest 0.1 cm using calibrated clinical weight scale and stadiometer. Body mass index (BMI) was calculated as the weight (kg) divided by the height squared (m^2). Being obese was defined as having BMI equal to or more than 95th percentile of BMI for age and sex.[2]

Exercise intensity evaluation:

An incremental symptom-limited exercise test on an electronically braked cycle ergometer was done for all participated children according to the recommended standards to assess maximum heart rate (HR max) used to determine aerobic exercise intensity for each child.[21]

Treatment:

All Children performed aerobic exercise training using stationary bicycle five days per week without any extra-ordinary dietary intervention, calorie intake or diet plan in both groups throughout the study. All children were asked to maintain the current level of physical activity during the other non-exercising days.

Aerobic Exercise Intervention:

Each child in either group A or B underwent 12 weeks; 5 times per week of supervised moderate intensity aerobic exercise training on the bicycle ergometer (Universal aerobicycle, made in USA). Aerobic training started with warming up (5-10 minutes) in form of pedaling on the cycle ergometer at low speed without any resistance. The active phase consisted of gradually increased time from 20-40 minutes of training according to child tolerance and gradually increased intensity from 50- 70 % of HRmax obtained from the incremental symptom-limited exercise test for each child. Recovery phase consisted of 5-10 minutes pedaling at low speed without resistance.[22]

3. Results:

Forty obese children (20 obese boys and 20 obese girls) commenced the 12-week aerobic exercise intervention and underwent final analysis at the end of the 12-week period. In the baseline evaluation, results of this study revealed no significant difference was recorded between the two groups before treatment (pre-test values) except for a difference on serum leptin level. There were no significant differences between the two groups before treatment in mean values of the age, height, weight, BMI, FVC and FEV_1 (Table 1). No adverse events were reported during the intervention.

Paired T- test was performed to examine and compare serum leptin, FVC, and FEV_1 within each study group. Results revealed that there were significant reduction in serum leptin in group A. Results revealed significant increase in FVC and FEV_1 in group A. (p-value < 0.05) (Figure 1 and 2).

Table 1: The pre-test values of the two groups.

Character	Study group (A)	Study group (B)	P-Value
	Mean ± SD	Mean ± SD	
Age (yrs)	11.9 ± 0.93	12.1 ± 0.7	0.565 **
Height (Cm)	150.35 ± 9.07	150.45 ± 10.4	0. 974**
Weight (Kg)	63. 05 ± 8.58	61 ± 7.83	0. 435**
BMI (kg/m^2)	27.51 ± 1.24	26.81 ± 0.97	0. 053**
FVC (L)	2.24 ± 0.37	2.07 ± 0.29	0.111 **
FEV_1(L)	1.93 ± 0.28	1.83 ± 0.26	0.255 **
Leptin (ng/ml)	18.3 ± 2.99	22.85 ± 2.11	0.000 *

Level of significance at P<0.05. * = significant ** = non-significant

SD: standard deviation, yrs: years, Kg: kilogram, cm: centimeter, L: liter.

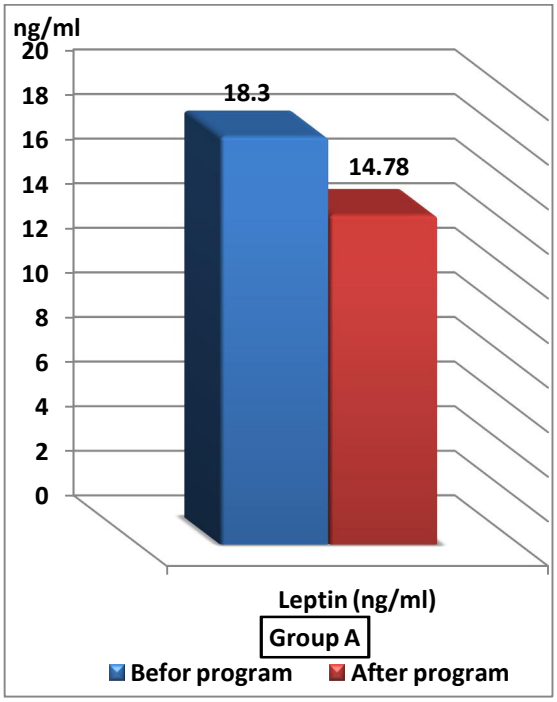

Figure 1: Comparison between pre-test and post-test values of serum leptin in group A

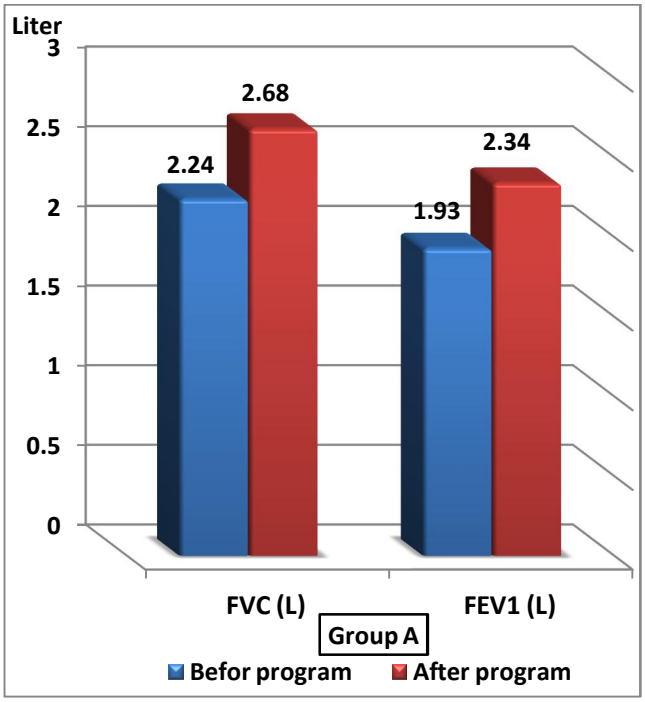

Figure 2: Comparison between pre-test and post-test values of FVC and FEV_1 in group A

Also Results revealed that there were significant reduction in serum leptin in group B. Results revealed significant increase in FVC and FEV_1 in group B. (p-value < 0.05) (Figure 3 and 4).

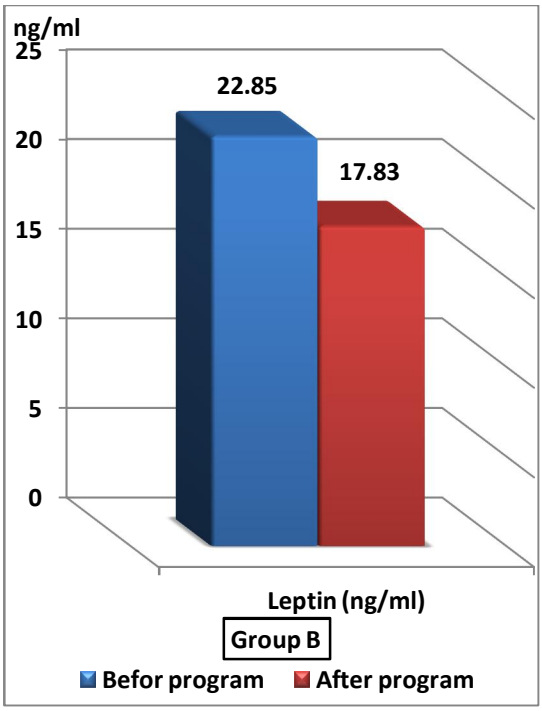

Figure 3: Comparison between pre-test and post-test values of serum leptin in group B

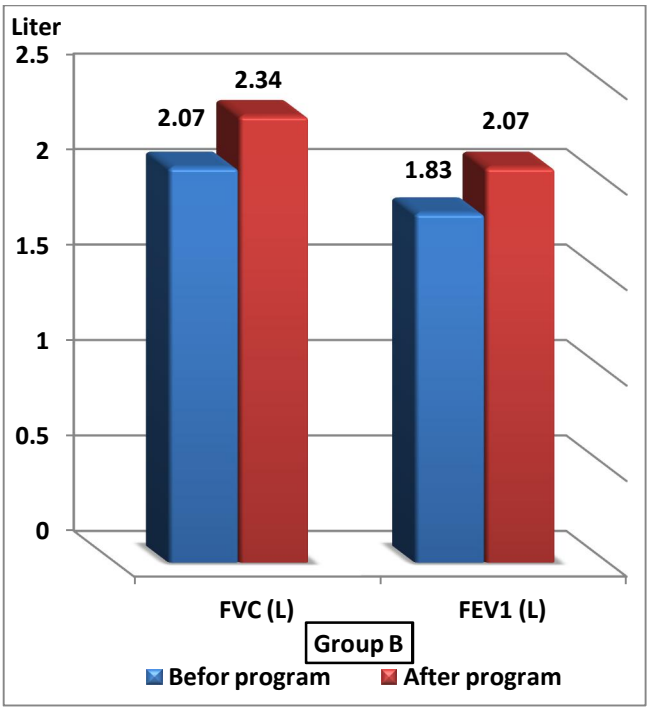

Figure 4: Comparison between pre-test and post-test values of FVC and FEV1 in group B

Unpaired t-test was performed to compare the post study mean values of serum leptin level, FVC and FEV_1 between the two groups. Results revealed that there were significant differences between the two groups after treatment in the mean values of serum leptin, FVC, and FEV_1 (Figure 5 and 6) (P-value < 0.05).

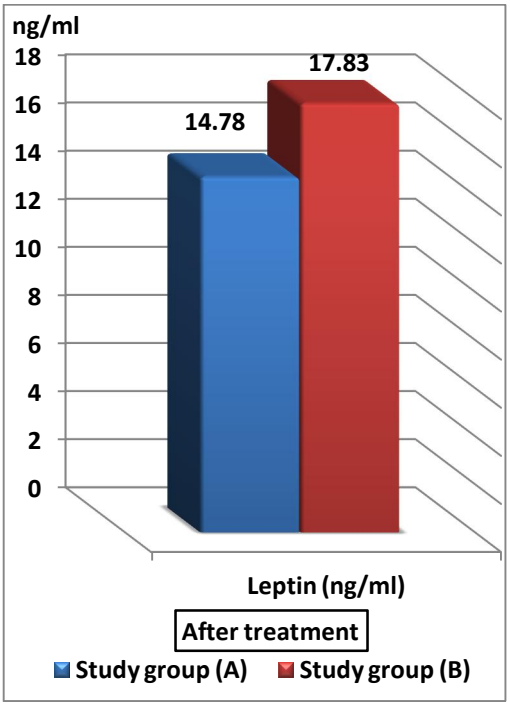

Figure 5: Comparison between mean values of Leptin between study groups after the exercise program

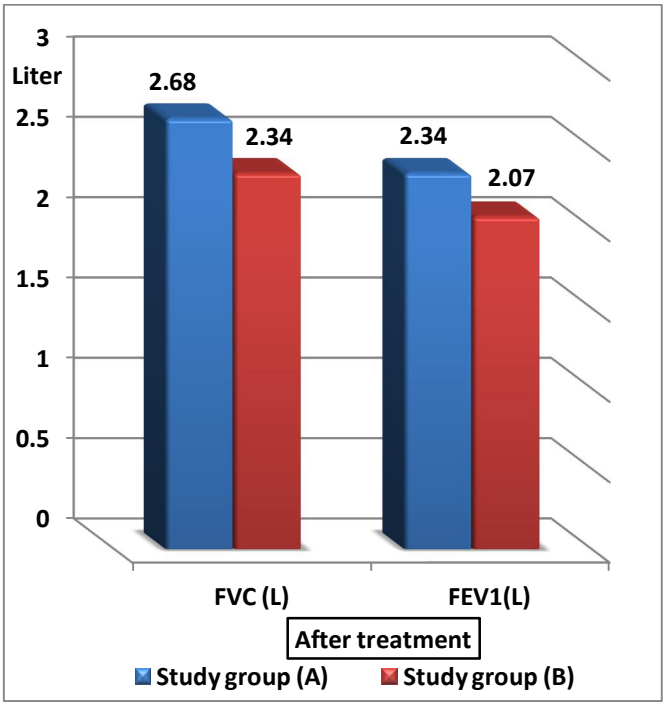

Figure 6: Comparison between mean values of FVC & FEV_1 between study groups after the exercise program

Result of this study also revealed that after 3 months of aerobic exercise training; the percentages of change in serum leptin and BMI for study group B were more than those for group A. In the contrary; the percentages of change in FVC and FEV_1 for study group A were more than those for group B (Figure 7).

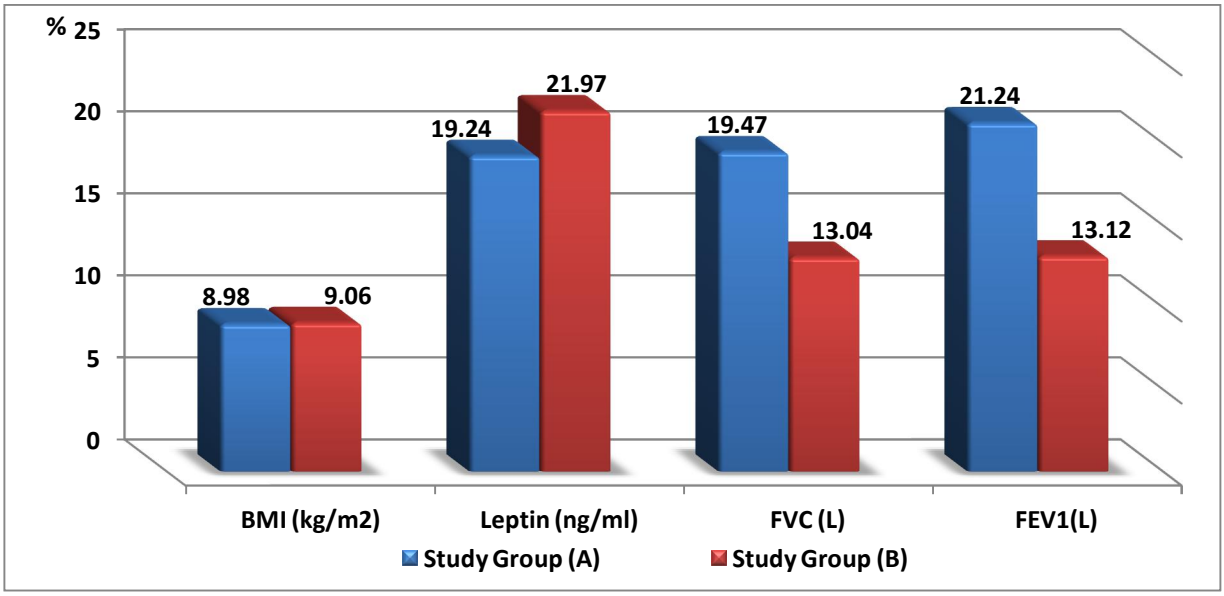

Figure 7: Percentage of change in leptin, FVC, FEV_1 and BMI of the two groups

4. Discussion:

The results of the present study showed that there was a significant reduction in BMI in both groups. But the reduction in the obese girls group was higher than the reduction in the obese boys group. This result is supported by a study compared the effect of aerobic and anaerobic training on obese subjects and reported that aerobic training induced a significant reduction in BMI and that the BMI reduction produced by aerobic exercise is more than that produced by anaerobic exercise training in children.[23] Similar results were demonstrated by Reybrouck et al., [24] who compared the effect of 4 months intervention of a low-calorie diet combined with aerobic exercise therapy to a low-calorie diet alone in obese children aged 4–16 years. Exercise group show a significantly larger decrease of percentage overweight than in those treated with diet alone These results was agreed with Gutin et al., [16] who demonstrated that a 4-month programme involving 40 minutes of aerobic exercise 5 days per week resulted in significant reduction in the levels of body fat in obese 7 to 11 year old children when compared with an obese control group. Furthermore; it was mentioned that physical activity alone can have considerable benefit for the overweight or obese children. It was determined that regular and long term aerobic exercises (12 week aerobic exercise program) had positive effects on BMI of obese girls.[25]

The results of the present study also proved that aerobic exercise training reduces serum leptin in obese children and that serum leptin responds more favorably in obese girls than that in obese boys. Study results concerning serum leptin response to aerobic exercise come in line with weight loss studies in children demonstrated that leptin concentrations in obese children decreased with physical training and that greater reduction in leptin during physical training was seen in those children who had higher pre-training leptin concentrations.[26]

Leptin level is not only elevated in obese girls compared with obese boys but it seems that it is also elevated in healthy girls compared with healthy boys. Romon et al., [27] described gender differences in the plasma leptin in relation to daily physical activity in children and confirm this result. Leptin response to aerobic exercise in obese children may be explained on the basis that aerobic training induces significant physiological adaptations and alters concentrations of certain hormones that may alter leptin concentrations, including insulin, cortisol, catecholamines, estrogen, testosterone, and growth hormone.[28] Exercise training-induced reductions in leptin levels may be also attributed to alterations in glucoregulatory factors including improvements in insulin sensitivity and lipid metabolism.[10] Furthermore; the reduction in leptin concentrations in obese children after exercise training may be caused by changes in energy balance.[27] This was further supported by Kraemer et al., [23] who

reported that leptin levels decline 48 hours after long-term aerobic exercise suggesting that there is a delayed reduction in leptin that may be due to energy imbalance. The decline in leptin concentrations may be associated with elevated production of non-esterfied fatty acids during exercise, which are inversely correlated with leptin levels.[29]

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, control of breathing and gas exchange.[30] Studies evaluating the effect of overweight on pulmonary function have produced variable results. This may be because of variable criteria for measuring obesity, numbers of included obese subjects, and variable degrees of obesity. However, in children the contribution of adipose tissue and the level of obesity at which pulmonary function is affected are not firmly established.[31] Inselman et al., [32] Confirmed that, in relation with theoretical values for sex, age, and height, the expiratory reserve volume, FEV_1, FEF25-75, maximal voluntary ventilation (MVV), and absolute and corrected alveolar diffusion capacity (DLCO) were reduced in obese subjects.[32] That was explained with abnormality in alveolar diffusion with possible structural alterations of the lung interstice by lipid deposition and/or a reduction in alveolar surface area.[33]

Results obtained in the present study indicated that aerobic exercise training program induced significant increase in FVC and FEV_1 in both obese boys and girls; in the favor of obese boys group. Higher percentages of change in both variables were noticed in obese boys when compared with that of obese girls. This comes in accordance with Jones and Nzekwu[30]; who concluded that aerobic exercise training in children with mental disabilities leads to improve the lung function parameters (FVC and FEV_1).[30] Results of the present study come in line with Ferdowsia et al., [34] who concluded that aerobic exercise had significant effect on lung function and trachea indexes in male over weighted students. It seems that increase in FVC after aerobic exercise was due to increased volume of the lungs and also the lungs elastic return. On the other hand FVC affected by the intercostal muscles. Therefore, improvement in respiratory muscle strength and endurance will increase the FVC in turn.[35]

Summary and Conclusion:

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 serum leptin level and ventilatory function in obese children. While aerobic exercise reduces serum leptin in both obese boys and girls; response of serum leptin to aerobic exercise in obese girls was better than serum leptin response to aerobic exercise in obese boys. Moreover; although aerobic exercise improved ventilatory function in both obese boys and girls; it seems clearly that response of ventilatory function in obese boys were much better than those of obese girls. It is recommended to use aerobic exercise in order to reduce serum leptin level and improve ventilatory function in obese children.

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