International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Effect of Aerobic Training on Peak Expiratory Flow Rate and Body Mass Index in Overweight Adolescents

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Received: 28/09/2014 *Revised: 27/10/2014* *Accepted: 10/11/2014*

ABSTRACT

Background: The peak expiratory flow rate (PEFR) is an important and simple determinant of ventilatory functions. Increased body weight, especially in adolescents, has a negative impact on functional performance. Here an experimental study of the effect of aerobic exercise program on those subjects regarding ventilation and body weight.
Objective: To investigate the effect of aerobic exercise training on PEFR and BMI in overweight adolescents.
Material and Methods: Sixty overweight participants were randomized to 2 groups, experimental and control groups, each group contains 30 subjects. The experimental group participated in 12-week aerobic exercise program. The control group had no plan of exercise during that period of time. PEFR and BMI were recorded before and after 12 weeks of training in both groups.
Results: After 12 weeks of treatment, the PEFR improved by 13% in the experimental group, while no significant change was observed regarding BMI.
Conclusion: This study demonstrated that aerobic training can improve PEFR significantly in overweight adolescents without significant change in BMI over 12 weeks.
Key words: Aerobic training, Peak expiratory flow rate, BMI, Overweight.

INTRODUCTION

Obesity and overweight are known to be a major risk of whole range of cardio vascular, metabolic and respiratory disorders. Various studies showed that obesity has various effects on respiratory system by producing obstructive sleep apnea, obesity hypoventilation syndrome and abdominal compartment syndrome. The World Health Organization (WHO, 2013) predicts that, by 2015, around 700 million adults will be obese (at least 10% of the projected global population). [1]

Assessment of body mass index (BMI) is a reliable tool for categorization of healthy and diseased people in aspect of weight, [2] i.e. it is also helpful in measuring the body composition and adiposity among adults and children. [3]

Peak expiratory flow rate (PEFR) is one of the important parameters in pulmonary function testing that has been evolved as clinical tools for diagnosis, management and follow up of respiratory diseases. For the assessment of ventilatory capacity, PEFR is considered to be the simplest one among the pulmonary function indices. [4-6]

PEFR is the highest flow value measured during forced expiration. It is an effort-dependent value. PEFR measures how fast a person can exhale air. It is one of many tests that measure how well our airways work. It is a simple method of measuring airway obstruction and it will detect moderate or severe disease. [7] Factors which determine PEFR are airway obstruction, closure and compression of small airways, strength of expiratory muscles and the lung and chest mechanics. Impaired pulmonary functions are associated with increased mortality and morbidity. [8-10]

Gundogdu Z et al. [3] reported a significant inverse relationship between BMI and PEFR among all age groups. Moreover, Ulger et al. [11] found the same negative correlation between BMI and basal forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), and peak expiratory flow rate (PEFR) values in children.

Aerobic exercise is an important component of pulmonary rehabilitation for patients with chronic obstructive pulmonary disease (COPD). The American College of Sports Medicine (ACSM) defines aerobic exercise as "any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature." It is a type of exercise that overloads the heart and lungs and causes them to work harder than at rest, like as walking, jogging, running, skipping, dancing, swimming, bicycling. [12]

Regular physical activity is associated with enhanced health and well-being. The results of numerous studies have revealed that regular physical activity is widely recognized as a mean of preventing the occurrence of many chronic diseases and reduced risk of all-cause mortality. [13-16] Research has shown reduced risk of cardiovascular and heart diseases, type 2 diabetes, some types of cancer, osteoporosis, fall-related injuries, depression, and obesity. [17] For this reason, it has been observed a worldwide increase in health enhancing physical activity interest among researchers. [18]

Physical activity at moderate-intensity at least 30 min on most days should be sufficient to diminish cardiovascular disease risk like as high blood pressure (hypertension), coronary heart disease (CHD), stroke, rheumatic heart disease and other forms of heart disease. [18] Protective effects of physical activity on overweight and obesity are well documented by Jethon and Wierzbicka-Damska [19] The authors concluded that physical exertion without help of diet is moderately effective in reduction of a body weight among overweight or obese individuals.

There are few studies on aerobic exercise and pulmonary function in overweight subjects. Exploration of the relation between aerobic exercise and respiratory functions will aid in understanding the mechanisms of how aerobics improve patient's quality of life and in finding a better way to evaluate the effects of rehabilitation. So, the aim of this study was to investigate the effect of aerobic exercise training on PEFR and BMI in overweight adolescents.

MATERIALS AND METHODS

The study was carried out at the department of Physiotherapy of the College of Applied Medical Sciences, Taif University, KSA, from January through July, 2014. This study was approved by ethical committee of the College. A sample of 60, overweight students participated in the study and were randomly allocated (through simple random sampling) to either experimental or control groups. Sample size was estimated according to Statistical Power Analysis-G*power, as the dependent variables are continuous with small standard deviation.

Inclusion criteria of subjects are; overweight (BMI ranged from 25 to 29.9), medical male students, aged 18-22 years, non-athletes and non-smokers. Exclusion criteria are; any recent history of respiratory, cardio pulmonary disease or any other disease which may affect lung function. Informed consent was obtained before participation (Appendix-1). Table 1 presents the demographic data of the participants of both groups.

Table 1: Demographic data of participants

Groups	Experimental group	Control group
Age (years)	20.35±2.31	20.84±2.01
Height (cm)	167.5±2.51	170± 1.76
Weight (kg)	77.14±1.45	79.04± 1.01
BMI (Kg/m^2)	27.61± 1.52	27.33± 1.64

Participants were randomly distributed into experimental and control groups each group contains 30 subjects. The experimental group participated in 12-week aerobic exercise program (30-minute sessions of bicycling [moderate-intensity activity-level 12-14 on Borg scale for Rating of Perceived Exertion], five days per week, with 5 minutes of warm-up exercise before aerobic practice and 5 minutes of cool-down exercise after the practice), while the control group had no plan of exercise during that period of time.

PEFR was recorded by computerized spirometer (spirolab *III*, Medical International Research Company) with the subject in a standing position as described, [20-24] before and after 12 weeks of training in both groups. The subjects were asked to breathe out maximally into the peak flow meter after taking a maximum inspiration. It was ensured that a tight seal was maintained between the lips and mouthpiece of the spirometer. Three readings were taken in three minute intervals with the highest reading recorded as the peak flow rate. The calibration of the spirometer and all testing protocols were performed as outlined in the instruction manual of the spirometer. The BMI values of both groups were measured before and after 12-week aerobic exercise program. BMI was calculated as body weight in kilogram divided by body height in meter square. [25]

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS version 16). Paired t-test was used to compare between pre and post values of each group, and unpaired t-test was used to compare between groups. The level of significant was set at 0.05 for all statistical tests.

RESULTS

There was no significant difference between groups in age, height, weight and BMI ($p > 0.05$) before the study. For PEFR, there was no significant difference between the pre values of both groups ($p > 0.05$). There was a significant improvement in the PEFR of the experimental group ($p < 0.05$) after 12 weeks aerobic training without any significant increase in the post values of control group ($p > 0.05$). There was a 13% improvement in PEFR in the experimental group, as shown in table 2. Regarding BMI, there was no significant improvement neither in the experimental group nor the control group, as shown in table 3.

Table 2: The peak expiratory flow rate values of both groups

Parameter	Experimental group	Control group
Pre-treatment PEFR (L/min)	463.13±40.67	465.40±33.61
Post-treatment PEFR (L/min)	524.67±43.85	470.2±34.2
P value	*(P=0.007)	**(P=0.1176)

*(S): Significant ** (NS): Non-significant

Table 3: BMI mean values of both groups

Parameter	Experimental group	Control group
Pre-treatment BMI (Kg/m^2)	27.61± 1.52	27.33± 1.64
Post-treatment BMI (Kg/m^2)	27.01± 1.4	27.29± 1.61
P value	**(P=0.117)	**(P=0.924)

** (NS): Non-significant

DISCUSSION

Obesity and pulmonary function have a historical association. Unlike investigations conducted in adults, studies of physical activity and cardiorespiratory fitness in overweight adolescents are still scarce and inconclusive. [26] Among the different systems affected by obesity, the respiratory system deserves special attention, as obesity can cause changes in respiratory function, exercise tolerance, pulmonary gas exchange, respiratory pattern, and strength and endurance of the respiratory muscles. [27]

Decreased physical activity and low cardio-respiratory fitness are recognized as important causes of morbidity and mortality. [8-10] It is generally accepted that people with higher levels of physical activity tend to have higher levels of fitness and that physical activity can improve cardio-respiratory fitness. [28] The current study was conducted to examine the effect of 12 weeks aerobic exercise training on PEFR and BMI in overweight adolescents.

Several studies support the association between obesity and PEFR. It has already been reported that PEFR is lower in obese children. [29,30] Kumar et al. [11] reported that pulmonary functions tends to reduce with age, but they also found the PEFR to reduce more in obese individuals in comparison to the non-obese group. This kind of association is probably due to the increased airway resistance and respiratory muscle dysfunction as a result of excess fat deposition. According to Tantisira et al. [31] high BMI is positively associated with spirometric variables like FEV1, FVC, PEFR.

Negative correlation between increasing obesity and BMI, along with other obesity indices, like weight-waist circumference, hip circumference, waist to hip ratio have been found in adolescents. [32] In this case also a contradictory finding has been reported in adult males, indicating insignificant association between obesity markers and lung function parameters. [33] However, the results of the present study proved that there was an association between aerobic exercise training and improvement of lung function as the PEFR increased significantly in the experimental group after 12 weeks of aerobic exercise program, in spite of the both groups had similar conditions at the beginning of the study.

Exercise is a stressful condition that produces marked change in body functions, improves endurance and reduces breathlessness. Skeletal muscle control many crucial elements of aerobic conditioning, including lung ventilation. The possible explanation could be that regular forceful inhalation and deflation of the lungs for prolonged periods leads to strengthening of respiratory muscles. [34] There might be an increase in the maximal shortening of the inspiratory muscles as an effect of training, which has been shown to improve lung function. [35]

As far as airways are concerned, activity-induced bronchodilation reduces airway resistance and improves pulmonary ventilation. It is known that normally the volume and pattern of ventilation are initiated by neural output from the respiratory centre in the brainstem. This output is influenced by input from chemoreceptors, proprioceptors in muscles, tendons and joints and impulses sent by nerves to the intercostal and diaphragmatic muscles. [36]

Exercise training increases the PEFR may be due to an increase in respiratory muscle strength. Peak flow rate is higher in fitter, healthier population such as armed forces personnels and athletes. [37] Chaitra and Maitri [38] found that PEFR improved after aerobic exercise. They reported that 16 weeks aerobic exercise plan (five 20 minute sessions of jogging in a week) can improve the PEFR up to 17% significantly. Moreover, our result are consistent with the findings of Cheng and Macera [39] who showed in their study that physical activity improved pulmonary function in healthy sedentary people. In addition, the present study corresponds with Farid et al. [40] who showed an improvement in pulmonary function with aerobic exercise training in asthma patients.

Nourry and Deruella [41] showed that aerobic exercise training improves pulmonary function in children. Fitch et al. [42] studied the effect of 5 month swimming training on school children with asthma and found improved lung function, and improved posture and fitness. Bruce et al. [43] have shown that distance running program improved fitness in asthmatic children without pulmonary complications or changes in exercise induced bronchospasm. In addition, Kaufman et al. [44] studied the effect of aerobic training on ventilatory efficiency in overweight children, and found that the training helped to reverse the decrements in cardiopulmonary function observed overtime in overweight children.

On the other hand, our study didn't reveal a significant improvement in BMI in the experimental group over the training period of moderate-intensity aerobic exercise, possibly due to the short duration of each session. In relatively inactive people, increasing physical activity can result in an increase in lean body mass, therefore; it is certainly possible that the amount of weight loss did not fully reflect the amount of fat loss. Second, exercise participants might have reduced their daily physical activity, partially counterbalancing the increased energy expenditure from the exercise intervention. [45]

Our study has several limitations. Firstly, the assessment conducted only before and after 12 weeks of interventions, In future studies, it is follow up assessment after 6 or 12 months to examine the maintained effect of the exercise programs. Secondly, the participated subjects were male only, so that the results are confined to this specific population that may affect the generalization of the results. Finally, the only pulmonary parameter examined in this study was PEFR. Other pulmonary parameters, such as FVC, FEV1 and MVV were not considered.

CONCLUSION

Moderate-intensity aerobic training can improve PEFR significantly in overweight adolescents over 12 weeks without a significant change in BMI; and thus provides further support for the aerobic exercise being an important component of pulmonary rehabilitation as well as to improve cardiopulmonary fitness in overweight adolescents. The health care community should better recognize aerobics as a complement to conventional medical care.

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How to cite this article: Abdel-fattah MS, Abdel-aziem AA. Effect of aerobic training on peak expiratory flow rate and body mass index in overweight adolescents. Int J Health Sci Res. 2014;4(12):215-222.

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