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Original Article

Comparison of peak expiratory flow rate (PEFR) before and after physical exercise in obese and non-obese children

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Abstract

Background Obesity has been associated with respiratory complications and it is believed to reduce lung volume. Obesity imposes additional stress on ventilation during exercise and may even result in pulmonary function impairment. Exercise induced-bronchospasm has also been found in obese children. Lung function tests can be useful to confirm diagnosis, response to therapy, or prediction of lung and respiratory diseases. The peak flow meter is an inexpensive, practical way to measure lung function, and can detect the early warning signs of a decrease in lung function.

Objective To compare the peak expiratory flow rate (PEFR) before and after physical exercise in obese and non-obese primary school boys aged 6 to 12 years old.

Methods A quasi-experimental study using the one group pretest-posttest design was performed on 30 obese children (BMI above the 95th percentile) and 30 non-obese children (BMI between the 5th – 85th percentile) using a mini-Wright peak flow meter to evaluate the PEFR before and after eight minutes of physical exercise. Height, weight, body mass index, and physical status were determined before testing.

Results The PEFR before and after exercise were 14.80 for obese children and 9.76 for non-obese children. The mean value for PEFR between obese and non-obese children was significantly different ($P<0.05$).

Conclusion The PEFR for obese children is significantly lower than non obese children even before physical exercise. **[Paediatr Indones. 2009;49:20-4]**.

Keywords: *peak expiratory flow rate, obesity, physical exercise*

Pediatric obesity is an important health problem and represents an uncontrolled worldwide epidemic. There is an increasing prevalence of pediatric and adolescent obesity in Europe, USA, and even in less developed countries.[1] The prevalence of childhood obesity is estimated to be 25 to 30 percent, and since 1981, it has increased by 54% in children aged 6 to 11 years. Medical record data of Medical School, University of Indonesia, Cipto Mangunkusumo Hospital, showed that there were 100 new cases of obesity in the Pediatric Department during the period from 1995 – 2000.[2]

Obesity imposes additional stress on ventilation during exercise and even results in pulmonary function impairment. In fact, physical activities are more strenuous for obese children than their healthy non-obese peers. They become breathless more easily during graded exercise.[3] Pulmonary function tests have long been recognized as an important medium for

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determining a number of lung disparities. Nowadays, with the increasing frequency of respiratory and pulmonary disease, the role of lung function tests is recognized as being more and more important in diagnosis, assessment of efficacy of therapy, and also in forecasting various respiratory and pulmonary diseases.[4,5]

A peak flow meter is a small, portable, easy to use instrument that provides an inexpensive and practical way to measure lung function. Peak flow data can provide early warning signs for illness and in some cases may show a decrease in lung function one to three days before other respiratory symptoms become evident. Height, sex and age determine predicted peak flow values. There are three peak flow zones that based on the traffic light concept: the green zone (80% - 100%) that indicates good lung function, the yellow zone (50% - 80%) signals caution and indicates that the large airways are getting too narrow, and the red zone (≤ 50%) indicates a severe narrowing of the large airways has occurred.[6,7] We studied the PEFR values before and after exercise in obese children as compared with that in non-obese.

Methods

An experimental study using a pretest and posttest design was performed to collect data during this study. We recruited 30 obese and 30 normal body weight boys, aged 6-12 years, from Harapan Elementary School. Initial criteria of obese children were a body bass bndex (BMI) above the 95th percentile, and 5th to 85th percentile for normal body weight children.

Subjects completed a medical history questionnaire. Informed consents from subjects and their parents were obtained at the beginning of the assessment. Each child was examined to assess his/her physical status. Subject weight was measured with a Camry® digital weighing scale with an accuracy of 0.1 kg, and standing height in cm was measured using a Heigh® stature meter with an accuracy of 0.1 cm.

Peak expiratory flow rate (PEFR) measurements were obtained using an APS mini-Wright peak flow meter. The research staff taught the children how to use the device and observed the children using the device correctly. The recorded measurement was the highest of three maximal expiratory readings obtained. The second measurement was recorded five minutes after a free running for eight minutes. Mean PEFR at baseline were calculated for the obese and non-obese group.

Statistical analyses were performed using SPSS for Windows statistical software (release 12, SPSS Inc., Chicago, IL). The *t* independent, chi-square, Mann Whitney and Fisher exact tests were used to compare the obese and non-obese group and the PEFR measurements. The level of significance was <0.05 in all comparisons.

Results

There was no difference in the characteristics of the study population with respect to the mean age and height between the obese and non-obese children, but the body weight and BMI were significantly different (**Table 1**).

Tabel 1. Subjects' characteristics

Characteristic	Obese (n = 30)		Non obese (n = 30)	
	Mean	SD	Mean	SD
Age (yr)	10.5	1.01	9.9	1.22
Weight (kg)	58.5	13.34	37.3	6.02
Height (cm)	147.7	11.02	142.8	6.33
BMI (kg/m2)	27.3	4.62	18.2	2.31

Table 2. Comparison of peak expiratory flow rate (PEFR) for obese and non-obese children before physical exercise

	Obese (n = 30)	Non obese (n = 30)	P
	Mean (SD)	Mean(SD)	
PEFR	236.8 (41.91)	276.1 (37.87)	0.0001
Percentage			
80-100%	20 (33%)	30 (50%)	0.001
50-79%	10 (16%)	0 (0%)	

Table 3. Comparison of peak expiratory flow rate (PEFR) for obese and non-obese children after physical exercise

	Obese (n = 30)	Non obese (n = 30)	P
	Mean (SD)	Mean (SD)	
PEFR	222.0 (41.35)	266.4 (38.57)	0.0001
Percentage			
80-100%	16 (27%)	27 (45%)	0.0002
50-79%	14 (23%)	3 (5%)	

Table 4. Comparison of peak expiratory flow rate (PEFR) for obese and non-obese children before and after physical exercise

	Before	After	P
Obese (n = 30)	Mean (SD)	Mean (SD)	
PEFR	236.8 (41.91)	222.0 (41.35)	0.0001
Percentage			
80-100%	20 (33%)	16 (27%)	0.292
50-79%	10 (17%)	14 (23%)	
Non obese (n = 30)			
PEFR	276.1 (37.87)	266.4 (38.57)	0.0002
Percentage			
80-100%	30 (50%)	27 (45%)	0.237
50-79%	0 (0%)	0 (0%)	

From the result of the PEFR measurements, the mean of PEFR for obese children was 236.8 before physical exercise, decreased to 222.0 after exercise (**Tables 2, 3 and 4**).

For non-obese children, the mean of PEFR was 276.1 before exercise, decreased to 266.3 after exercise. Ten children from the obese group were in yellow zone before exercise (17%) and this increased to 14 children (23%) after exercise. For non-obese children, no individuals were in the yellow zone before exercise but three children were classified as being in the yellow zone after exercise. There was a significant difference in the decrease of mean PEFR value between obese and non-obese children ($P<0.05$).

Discussion

Obesity is a condition in which a person has excess body weight relative to other people of the same gender and height. Age-and gender-specific BMI has been the most widely used measurement to define obesity. Individuals in which BMI (weight in kilograms divided by the square of the height in meters) exceeds the age-and gender- specific 95th percentile are considered obese.[8,9] The groups of obese and non-obese children in our study were not significantly different in characteristics except for their body weight and BMI.

Respiratory problems are associated with obesity, and these occur when the added weight of the chest wall squeezes the lungs and causes restricted breathing. It is generally accepted that increased body mass loading of the respiratory apparatus (chest and lungs) plays a role in the development of respiratory failure by causing either an insurmountable load to the respiratory muscle or significant ventilation – perfusion inequalities.[10]

In this study, data collected by medical examination and from the questionnaire indicated that all of the children had never experienced any respiratory symptoms. However, our data showed that pulmonary function was significantly lower in the obese group, even before physical exercise. In their study, Belamarich *et al* found that obese children used more medicine, wheezed more, and a greater proportion had unscheduled visits to emergency departement than non-obese children. Kaplan *et al*[11] found that exercise-induced bronchospasm was found in obese but otherwise in healthy children. In fact, several studies (most of them cross sectional) have shown positive associations of obesity or high body mass index (BMI) with respiratory symptoms, asthma and airway hyper-responsiveness.[12] Li *et al*[13] in their study of 64 obese children found that reductions in functional residual capacity (FRC) and diffusion impairment were the commonest abnormalities found in obese children, and that reduction in lung static lung function was correlated with the degree of obesity. Gilliland *et al*[14] found that being overweight is associated with an increased risk of new-onset asthma in boys and in non-allergenic children. However, Tang, *et al*[3] did not find any significant difference between the obese and non-obese groups in any of the lung function measurements after a jump rope test for 10 minutes. Thus, many studies were not able to find any significant pulmonary abnormalities in obese children.

Exercise testing is an objective method of confirming exercise–induced bronchospasm. It is also valuable in diagnosing asthma, particularly in pediatric patients. Exercise–induced bronchospasm results from a transient increase in airway resistance that produces various symptoms (cough, wheezing, chest tightness, or pain) that may appear after five to 10 minutes exercise. Several types of exercise have been used (e.g. treadmill, cycle ergometer, rowing ergometer) but the highest rate of responsiveness is usually seen with free running. De la Rubia *et al*[15] performed a comparative study of free and treadmill running and found there were no significant differences in the percentage decrease in post-exercise performance after either of these provocation tests. When the physical activity stops, lung function decreases within the 5–10 minutes after the activity stops. Decreases in FEV1 or PEFR often range from 20% to 50%.[16-17] In this study, subjects performed an eight minute-free run to assess bronchus hyper-reactivity. Peak expiratory flow measurements were obtained just before and five minutes after the eight minutes free running test. The mean decrease rate of PEFR in obese children was 14.8 and 9.76 on non- obese children.

The mini Wright flow meter is widely used for measuring PEFR in home monitoring of asthmatics or for screening tests in community-based studies on respiratory illness. There are certain limitations in our study, such as the assessment of lung function at only one time point. It would be ideal to undertake a longitudinal study to assess the changes in lung function in relation to body composition over time. In addition, there may be inherent weaknesses in a simple device like the mini Peak Flow Meter (PFM) such as packaging, durability and limitations to lung function measurement. For example, there may be mechanical failures in the flow meter after prolonged use. Wirjodiardjo *et al*[18] considered that the effect of frequent use of the mini PFM on its efficacy and reproducibility should be evaluated. Although data appears consistent between various types of mini PFM, the individual meter used may affect results and so it would be better to use the same device regularly. We used new brand of PFM in this study, and each child used the same PFM to measure PEFR before and after physical exercise.

Peak flow measurements in this study were obtained with a standard way. In a standing position, the subjects took a deep breath then placed the device in the mouth and closed the lips around it with the tongue away from the hole. Subjects then blowed out as hard and fast as they can. The measured PEFR was compared with the subject's predicted PEFR, which was matched to the same sex, age, body size and ethnic group. Normal values and prediction formula have been established for children of European, American, African, and Asian origin. One problem is the difference in the PEFR values obtained when using a mini Wright PFM and an electronic spirometer. Wirjodiardjo found that the PEFR using PFM gave higher values.[19] According to Goldberg *et al*[20] although PEFR is an important tool in the management of asthmatic patients, it is not sensitive enough in detecting small airway function, and it is best used at home along with regular spirometer measurements performed at the clinic. Wirjodiardjo *et al*[18] recommended that air flow measurements collected with simplified devices such as mini Wright PFMs, especially in children, should be converted to the value measured by a standard electronic spirometer. Similarly in this study, we used the PEFR conversion table from the mini Wright manufacturer to compare the measured PEFR with the subject's predicted PEFR.

In conclusion, our results show that the peak expiratory flow rate before and after physical exercise is significantly lower in obese children compared with that in normal children.

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