Paediatrica Indonesiana

VOLUME 50 May • 2010 NUMBER 3

Original Article

Comparison of pulmonary function test results before and after exercise in junior high school students

Hendy Zulkarnain, Munar Lubis, Gabriel P, Ridwan MD, Helmi M. Lubis

Abstract

Background During exercise, bronchoconstriction occurs due to heat loss from mucosal respiratory tract. Exercise test can be performed to evaluate hyper-reactivity of the bronchus. The examination of pulmonary function is beneficial to confirm the diagnosis, to determine precipitating factors, and to evaluate disease severity and therapeutic response.

Objective To compare pulmonary function test values before and after exercise in junior high school students aged 13 to 15 years.

Methods Experimental study of 60 junior high school students from Bilah Hulu was performed using spirometry to evaluate pulmonary function before and after eight minutes of exercise.

Results Functional vital capacity (FVC) values before and after eight-minute exercise were 2.20 (SD 0.52) and 2.18 (SD 0.42), respectively. There was no significant difference between FVC values before and after exercise ($P>0.05$). The mean forced expiratory volume in 1 second (FEV_1) values before and after eight minutes of exercise were 2.21 (SD 0.42) and 2.13 (SD 0.50) respectively. There was no significant difference between FEV_1 before and after the exercise ($P>0.05$).

Conclusion Eight-minute exercise does not influence the pulmonary function test results in healthy children. **[Paediatr Indones. 2010;50:176-80]**.

Keywords: *exercise, pulmonary function test, spirometry*

Close relationship between exercise and asthma has been known for a long time. This relationship is now used to assess the long-term effects of asthma, to study of new drugs and their efficacy in treating exercise-induced asthma, and as a diagnostic tool in cases where the diagnosis of asthma is uncertain. Free-running is considered as the most asthma-inducing exercise. Nevertheless treadmill running is considered to be more useful in determining bronchial response to exercise, since the intensity and the conditions in which it is performed can be more thoroughly controlled.[1]

There are many reasons why exercise-induced asthma (EIA) is not recognized in children. Firstly, it occurs most commonly after exercise, so it may not exceed normal performance unless the child has moderate to severe asthma. Secondly, children may fail to notice the symptoms of EIA until they take part in organized or competitive sport. Thirdly,

From The Department of Child Health, Medical School, North Sumatra University, Haji Adam Malik Hospital, Medan, Indonesia.

Reprint request to: Hendy Zulkarnain, MD, Department of Child Health, Medical School, North Sumatra University, Haji Adam Malik Hospital, Bunga Lau no. 17, Medan, Indonesia. Tel. 62-61-8361721/8365663. Fax. 62-21-8361721

50% of children become refractory to the broncho-constricting effects of exercise when exercise is repeated within an hour of warm up.[3] Forced expiratory volume (FEV_1) and forced vital capacity (FVC) are simple and relatively cost-effective pulmonary function tests. FVC is the volume of air that can be exhaled in a forced expiration after a maximal inspiratory effort. FEV_1 is the volume of air that can be exhaled during the first second of a forced expiration after a maximal inspiratory effort. These tests are useful for confirming diagnosis, determining exacerbating factors, determining the severity of disease, and measuring treatment responses.[2,6]

Backer and Ulrik reported that 16% of a random sample of 494 Danish children and adolescents experienced more than 16% reduction in FEV_1 after a standardized exercise test.[7] Anna reported that in 63 children classified as having intermittent asthma, there was no significant relationship between baseline FEV_1 and the decline in FEV_1 after exercise.[8] In childhood, playing with other children and doing sport (physical exercise) are very important to increase self-confidence. However, these activities can induce asthma.[4] Therefore, it is very important to identify EIA in children early to ensure optimal growth and development.[7] De la Rubia[1] found that FEV_1 and FVC are sensitive diagnostic parameters, especially for exercise tests that can induce bronchoconstriction. FEV_1 test can be performed only in children older than 8 years of age.[2]

Methods

This study was conducted at PTPN III Hospital in South Aek Nabara Labuhan Batu District, North Sumatera, in the third week of March 2005. Pre- and post-pulmonary function test results were obtained to evaluate the effect of exercise on changes in FEV_1 and FVC. Sixty boys (13-15 years old) were recruited randomly from a population of junior high school students. Baseline data were recorded and each child was examined to assess their physical status.

We included healthy, male, junior high school students between the age of 13 and 15 years. Weight was measured with a Camry® digital weight meter with an accuracy of 0.1 kg. Subjects wore their school uniform without shoes when they were weighed. Height was measured with a Stature Meter Height® device (accuracy of 0.1 cm), placed vertically on the wall. Informed consent was signed by their parents and the study was approved by Ethics Committee of Medical Faculty of North Sumatera University.

The children were guided by an expert coach to take breath as deep as they could (maximal inspiration) and then to exhale as hard as they could through the exhalation pipe, which was connected to spirometer Spiro Lab II®. This process was done three times. The highest FEV_1 and FVC values were recorded. Next, the child exercised on a treadmill (Series 2000 treadmill, Marquet Medical System Inc) for 8 minutes then the second measurement of FEV_1 and FVC values were recorded using the same procedure described above.

Results produced from a suboptimal maneuver can give a misleading information. Therefore, both the individual coaching the child during the test and the physician interpreting the results must be able to recognize and reject an inadequate effort. Children who did not complete the entire study and who were not cooperative during the examination were excluded from analysis. Data were analyzed using SPSS version 10.0. A paired-*t* test was used to compare pulmonary function test values before and after exercise.

Results

The mean age of the subjects was 14 years, while the mean weight, height and BMI were 47 kg, 157 cm and 19 kg/m^2, respectively. The mean FEV_1 value before exercise was 2.21 L and became 2.13 L after exercise. The mean FVC values before and after exercise were 2.20 L and 2.18 L,, respectively. The FEV_1 and FVC values before and after exercise decreased, but the differences were not statistically significant.

Table 1. Subjects' characteristics

n = 60	Mean	SD	Minimum	Maximum
Age (year)	14	0.75	13	16
Weight (kg)	47	6.49	33	64
Height (cm)	157	7.22	139	172
BMI (kg/m2)	19	1.72	15	25

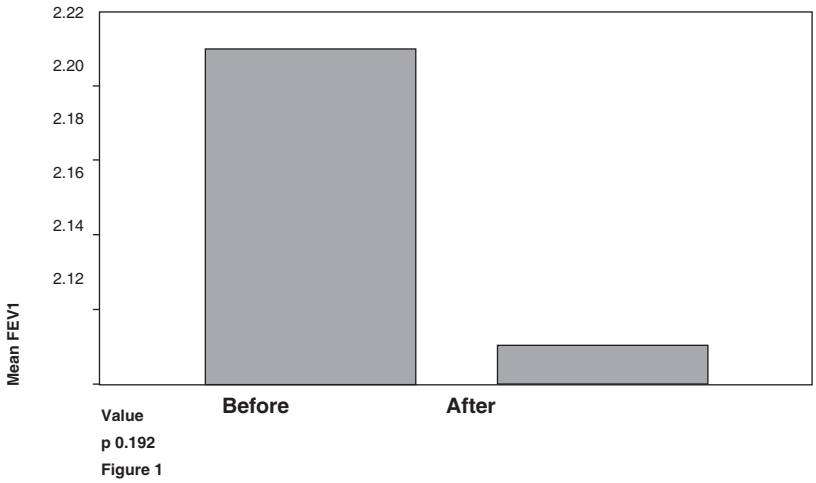

Figure 1. Comparison of FEV1 before and after exercise

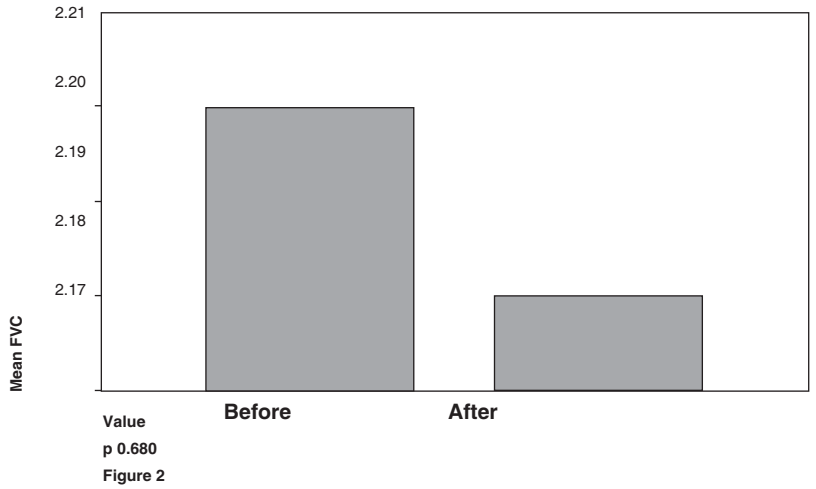

Figure 2. Comparison of FVC before and after exercise

Discussion

This study measured pre- and post-pulmonary function test in order to evaluate the effect of exercise on changes in FEV_1 and FVC. De la Rubia[1] found that FEV_1 and FVC are sensitive diagnostic parameters, especially for exercise tests that can induce bronchoconstriction.[1]

There are more useful numerical parameters derived from forced expiration consisted of forced vital capacity (FVC), peak flow (PF), forced expiratory volume (FEV_1) and forced expiratory flow between 25% and 75% of vital capacity (FEF_{25-75}). The volume exhaled from the deepest inspiration possible to the end of exhalation (FVC) is usually nearly identical to vital capacity measured during a slow exhalation but may be slightly smaller in individuals with airway obstruction.[9,18]

The volume exhaled during the first and second of exhalation (FEV_1) is the most dependable indicator of airway obstruction. Values of FEV_1 <80% or FEV_1/FVC <80% indicate an airway obstruction. An FEV_1/FVC ratio greater than 80% indicate normal airway function.[18,19]

Spirometry is a simple method that can measure most components of lung volume and capacity; the tool used for measurement is called a spirometer.[9] An electronic spirometer can measure various parameters of lung function, such as forced expiratory volume (FEV_1) or forced vital capacity (FVC) [14,16,17].

Exercise test was performed to evaluate bronchus hyperactivity. The principle is that bronchoconstriction occurs because of heat loss from respiratory tract mucous during exercise.[2] According to the literature, bronchoconstriction develops after six to eight minutes of vigorous exercise.[1,2,4,5] In this study, we wanted to evaluate whether there were any differences of pulmonary function test results (FEV_1 and FVC) before and after exercise in junior high school boys aged 13 to 15 years.

There are some reasons why EIA is difficult to identify:[3]

1. It occurs after exercise, therefore it is not so bothersome to a child during normal activities, unless the child suffers from moderate to severe asthma.
2. A child does not show any symptom of asthma until they engage in competitive exercise.
3. As many as 50% of children become refractory to the effects of bronchoconstriction when exercise is repeated within a few hours or if they warm up beforehand. Resistance to the effects of bronchoconstriction shows that asthmatic symptoms do not always occur every time a child exercises.

This study was performed on healthy children (there was no prior history of bronchial hyper-reactivity or the hyper-reactivity was difficult to identify).

Asthma is defined as chronic inflammation of the respiratory tract, with many cell involved - especially mast cells, eosinophils, and T lymphocytes.[2] Cabral et al[8] found that there was no significant relationship between FEV_1 values before exercise in children with different severities of asthma. This was probably because differences in responses to intense exercise would be found between children with mild asthma and children with severe asthma, but not in children with persistent asthma.[8]

Similarly, in this study, it was very difficult to compare the effect of exercise on children with mild and severe asthma due to research ethics. The exercise used in this study was running on a treadmill. Another study by De la Rubia[1] compared treadmill and free-running in children aged 6 to 14 years old. The result was that there was no significant difference in FEV_1 and FVC values between subjects who ran on a treadmill and those who did the free running. This is an important finding since most people believe that running is more asthmatogenic than cycling, walking, swimming or treadmill running.

In conclusion, there is no significant difference in pulmonary function test values (FEV_1 and FVC) before and after 8 minutes exercise in healthy boys aged 13 to 15 years.

References

1. De la Rubia SG, Fernandez MJP, Solis MS, Moro IMG, Flores DP, Ahumada MP. Exercise-induced asthma in children: a comparative study of free and treadmill running. Ann Allergy Asthma Immunol. 1998;80:232-6.
2. Munasir Z. Uji Fungsi Paru. In: Akib APA, Matondang SC, editors. Buku ajar alergi. Jakarta: IDAI, 1996; p. 315-8.
3. Anderson D S. Exercise-induced asthma in children: a marker of airway inflammation. Med J Aust. 2002;6:61-3.
4. Lacroix VJ. Exercise-induced asthma. Physician Sports Med. 1999;27:1-13.
5. Sudhir P, Prassad JE. Prevalence of exercise-induced bronchospasm in schoolchildren: an urban-rural comparison. J Trop Pediatr. 2003;49:104-8.
6. Panditi S, Silverman M. Perception of exercise-induced asthma by children and their parents. Arch Dis Child. 2003;88:807-18.
7. Carlsen Kai-Hakon. Exercise-induced asthma in children and adolescent and its relationships to sport. In: Naspitz KC et al, editors. Textbook of pediatric asthma, an international perspective. United Kingdom: 2001; p. 211-2.
8. Cabral ALB, Conceicao GM, Fonseca-Guedes CHF, Martins MA. Exercise-induced bronchospasm in children, effects of asthma severity. Am J Respir Crit Care Med. 1999;159:1819-23.
9. Guyton AC. Ventilasi paru-paru. In: Dharma A, Lukmanto P, translator. Buku teks fisiologi kedokteran. Jakarta: EGC, 1983; p. 1-13.
10. Wenzel SE, Larsen GL. Assessment of lung function: pulmonary disfunction testing. In: Bierman CW, Pearlman DS, Shapiro GG, editors. Allergy, asthma and immunology from infancy to adulthood. Philadelphia: WB Saunders Co, 1996; p. 157-72.
11. Wirjodiarjo M. Evaluasi klinik fungsi paru dalam pemecahan masalah kesehatan anak. In: Rahajoe N, Rahajoe NN, editors. Naskah lengkap pendidikan kedokteran berkelanjutan anak 33. Jakarta: FK UI, 1994; p. 45-73.
12. Aditama TY, Mangunnegoro H, Fachrurodji H, Depari,

Saharawati. Penggunaan arus puncak ekspirasi maksimum dalam penilaian faal paru. Medika. 1987;13 Suppl 7:670

13. Brodovich, Hugh M. The functional basis of respiratory pathology. In: Chernick V, Kendig EL, editors. Kendig's disorders of the respiratory tract in children. 4th ed. Philadelphia : WB Saunders Co, 1983; p. 3-46.
14. Wirjodiarjo M, Said M, Budiman HI. Perbandingan hasil pengukuran *peak flow rate* antara mini Wright peak flow meter dan spirometer elektronik pada anak. MKI. 1992;42 Suppl 10:575-85.
15. WHO. Deteksi dini penyakit akibat kerja. Wijaya C, editor. Suyono J, translator. Jakarta: EGC, 1995; p. 213-20.
16. Hodgin JE. Routine pulmonary function tests. In: Burton GG, Hodgkin JE, editors. Respiratory care a guide to clinical practice. 2nd ed. Philadelphia : JB Lippincott Co, 1994; p. 231-8.
17. Higenbottam T. Respiratory function test. Med Intl. 1986:1393-9.
18. Rudolph CD. The respiratory system. In: A Thomas, editor. Rudolph's pediatrics. New York: McGraw-Hill, 2003; p.1905-22
19. Saglimbeni JA. Exercise induced asthma. c2004 [cited 2005]. Available from: http://www.emedicine.medscape.com
20. Wirjodiarjo M. Daftar nilai baku fungsi paru anak usia SD di Jakarta. Jakarta: BIKA FK-UI, 1993; p. 1-8.
21. Rahajoe N, Supriyatno B, Setyanto DB. Pedoman nasional asma anak. Jakarta: UKK Pulmonologi PP IDAI, 2004; p. 2-3