

Sensitivity and Specificity of Self-Reported Symptoms for Exercise-Induced Bronchospasm Diagnosis in Children

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Abstract

Objective: Exercise-induced bronchospasm (EIB) is a common condition in elite athletes. The purpose of this study was to evaluate the diagnostic value of self-reported EIB symptoms in children.

Methods: In a cross sectional study in 2005, all soccer player boys of 3 football schools of Shahr Rey a town in the south of Tehran, enrolled in this study. All subjects were asked for the presence of four cardinal symptoms of EIB (cough, wheeze, shortness of breath, chest pain/discomfort) during and after exercise. Self reported symptom-based EIB was defined as having at least two out of four symptoms. Findings were compared to spirometric criteria as a gold standard test.

Findings: A total of 371 boys were enrolled in this study. The mean age of children was 11.67 ± 1.53 years (range 7-16 years). According to spirometric findings, 74 (19.9 %) subjects had EIB. The sensitivity and specificity of self-reported symptoms for EIB diagnosis were 13.0 % and 89.9 %, respectively.

Conclusion: Self-reported symptoms of EIB in children can be useful for epidemiological study. Our results in Iran are comparable with studies in other countries and point to a relatively high prevalence of EIB among athlete children.

Key Words: Exercise-induced bronchospasm; Soccer player; Spirometry; Exercise induced asthma; Children

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Introduction

Exercise-induced bronchospasm (EIB) is defined as airway obstruction that occurs in association with exercise without regard to the presence of chronic asthma^[1-3]. EIB may be the only clinical manifestation of asthma, although in some cases it is associated with persistent asthma or asthma that is triggered by exercise. The prevalence of exercise-induced bronchospasm (as an isolated manifestation of asthma) is reported to be present in 6 to 19% of the population^[3,4], but it is estimated that 70-90% of already diagnosed asthmatic patients suffer from EIB^[4, 5]. In addition, EIB occurs in as many as 10-50% of elite athletes^[6].

Diagnosis of EIB based solely on clinical symptoms is challenging. These conditions are important to recognize in children who exercise, as asthma may limit physical activity secondary to a decrease in pulmonary function. The questionnaires used in the majority of the studies have low-to-moderate sensitivity and specificity, with high false positive and false negative rates in adult group^[7,8]. Although self reported questionnaire was used in some studies in children, there is no evidence about sensitivity and specificity of questionnaire in other studies^[9,10].

The purpose of this study was to determine, based on spirometric criteria, the prevalence of reversible airflow obstruction among soccer player children in Iran and whether self-reported symptoms are sufficient to establish the diagnosis.

Subjects and Methods

In summer 2005, all soccer player boys of 3 schools of Shahr Rey, a town south of Tehran, Iran, enrolled in this study. According to prevalence of EIB (15%) and with 4% accuracy, sample size accounted 320 subjects. All subjects were asked not to engage in vigorous physical activity during 4 hours before the exercise test. In addition,

bronchodilator medications were withheld 6 hours before the exercise test. Informed consent was obtained from all participants. The study protocol was approved by the Ethics Committee of Tehran University of Medical Sciences.

All subjects were asked for the presence of four cardinal symptoms of EIB (cough, wheeze, shortness of breath, chest pain/discomfort) during and after exercise. Self reported symptom-based EIB was defined as having at least two out of four symptoms.

Spirometry was performed using Spirolab II (RDSM Co., Italy) in the seated position before, 6 minutes and 15 minutes after exercise. Three acceptable tests were obtained at each trial. The highest pre-exercise and the lowest post-exercise forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC) values were selected as representative. The forced midexpiratory flow at 25-75% (FEF_{25-75%}) values were selected from the performance in which the sum of FEV₁ and FVC values were maximal (pre-exercise)/minimal (post-exercise). After 5 minutes warm up, exercise was performed for 15 minutes soccer playing in natural grass-ground, while defibrillator system and salbutamol spray were kept at hand in case. Temperature was fixed between 24 and 27 °C and humidity was controlled between 26-30%. The diagnosis of EIB was based on a decrease in FEV₁ by at least 15% or in PEF_R or FEF₁₅₋₇₅ % by at least 25% after exercise challenge. Subjects were excluded if there was 1) impaired baseline lung function (FEV₁ <60 % of normal), 2) diagnosed asthma, 3) chronic respiratory diseases, 4) either recent upper respiratory infections or a history of lower respiratory tract infection during the past 6 weeks, 5) inability to raise heart rate to the desired level (85 % of the maximal heart rate), 6) cardiac arrhythmia, chest pain, or severe respiratory distress during the exercise, 7) inability or refusal to complete the exercise.

Statistical analysis computations were performed by SPSS 11.5. By comparing the spirometric results with self reported symptoms, sensitivity and specificity were

determined. Numerical variables were analyzed with the independent *t*-test, and categorical variables were analyzed with the Chi-square test. The level of significance was set as $P=0.05$.

Findings

Totally 400 children enrolled in this study, of whom 29 subjects were excluded (6 children had asthma, 14 children had recent upper respiratory infection, and 9 children refused to complete the exercise or spirometry test). 371 children aged 11.7 ± 1.5 years (range 7-16 years) with a BMI of 17.6 ± 2.6 kg/m² completed the study. Some findings of this study (in non-allergic children) have been reported previously^[11]. Seventy four (19.9%) subjects had EIB according to our spirometric criteria. Specifically, 19 (5.0%) subjects showed >15% drop in FEV₁, 20 (5.4%) showed more than 25% drop in PEF, and 38 (10.2%) showed more than 25% drop in FEF_{15-75%}.

The prevalence of EIB was 11.5% in goalkeepers, 22.5% in defense or halfbacks, and 13.9% in forwards. There was no significant difference between EIB prevalence and soccer players' roles ($P=0.1$).

The sensitivity and specificity of self-reported symptoms for EIB diagnosis were 13.0% and 89.9%, respectively. Positive predictive value was 24.3% and negative predictive value 80%. Table 1 shows demographic parameters in children with

and without EIB. There was no significant difference between EIB and demographic parameters, but the height had a borderline association with prevalence of EIB.

Discussion

Generally, EIB should be suspected in a patient complaining from coughing, wheezing, shortness of breath, or chest tightness/discomfort during or after exercise. The diagnosis is then confirmed by development of airway obstructive symptoms after an appropriate bronchial provocation test^[12]. EIB is usually identified by changes in pulmonary function measured before and after a standardized exercise challenge. A 10-20% reduction in FEV₁ or forced midexpiratory flow at 25-75% (FEF_{25-75%}) is usually considered as the spirometric criterion^[13,14].

Approximately 20% of the subjects in our study suffered from EIB. Diagnosis of EIB based solely on self-reported symptoms was associated with a high false positive rate (87%), and in this test there is only 24.3% positive predictive value. So, the self-reported symptoms are not proper for diagnosis evaluation and they are not recommended for screening of EIB. Other studies reported similar findings^[7,8,15,16]. In another study in our center, in young adults and study in the laboratory field, the sensitivity and positive predictive value of self-reported symptoms was 26.5% and 17.6%, respectively^[8]. This

Table 1: Mean (SD) of age, height, weight and body mass index in two group of soccer players with and without exercise bronchospasm in Shahreray/ Iran

Variable	Total	EIB Positive	EIB Negative	P. Value
Age MEAN(SD)	11.67 (1.53)	11.24 (1.64)	11.80 (1.48)	0.4
Weight MEAN (SD)	40.54 (10.31)	37.65 (9.89)	41.37 (10.30)	0.1
Height MEAN (SD)	150.5 (12.2)	146.2 (12.6)	151.8 (12.0)	0.08
Body Mass Index	17.66 (2.66)	17.38 (2.53)	17.73 (2.69)	0.6

finding shows EIB is only proven by PFT and many patients do not have any symptoms.

In our study, the specificity of self-reported symptoms was high (89.9%) and negative predictive value was 80%. Our findings were similar other studies^[7,15,16]. This finding shows when at least two of the main four EIB symptoms are reported by subjects, it can be useful for epidemiologic evaluation. In the study of Mansournia et al, the specificity and negative predictive value of self-reported symptoms were 26.5% and 84.9%, respectively^[8].

In this study, the prevalence of EIB was about 20%. It is slightly higher than in other studies in adult groups. Mansournia et al reported the prevalence of EIB to be 10.8% (in males and females) and 15.9% in males^[8]. In school children in Kenya, the prevalence of EIB was 13.2 in rural and 22.9% in urban children^[9]. However, there are studies that show high EIB prevalence of about 30% and higher in children^[17,18]. It seems the prevalence of EIB in athletes is less than that in general population. In our previous report, in non-allergic soccer children, the prevalence of EIB was lower than in general population (6-15.8% vs 19.9%)^[11]. In one study among Tunisian elite athletes this rate was a little higher than 10% and the same result was reproduced in another study on 1984 US Summer Olympic team members^[19,20].

The strongest point of this study was the large sample size and investigation of soccer players. There are some factors that could have caused decrease in EIB prevalence in our subjects. Warm up before exercise can decrease the prevalence of EIB, due to induced refractory period^[21]. On the other hand, grass pollen and air pollution could be trigger factors for EIB, and increase the prevalence of EIB in our study.

Conclusion

Our study indicated that self-reported symptoms have a low sensitivity in

establishing the diagnosis of EIB, but it has a proper specificity and negative predictive value. In addition, EIB prevalence is a common condition among soccer player children.

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References

1. Cummiskey J. Exercise-induced asthma: an overview. *Am J Med Sci.* 2001;322(4): 200-3.
2. Weiler JM. Exercise-induced asthma: a practical guide to definitions, diagnosis, prevalence, and treatment. *Allergy Asthma Proc.* 1996;17(6):315-25.
3. Liu AH, Spahn JD, Leung DYM. Childhood asthma. In: Behrman RE, Kliegman RM, Jenson HB. *Nelson Textbook of Pediatrics.* 17th ed. Philadelphia, Saunders. 2004; Pp: 760-73.
4. Massie J. Exercise-induced asthma in children. *Paediatr Drugs.* 2002;4(4):267-78.
5. Beck KC, Joyner MJ, Scanlon PD. Exercise-induced asthma: Diagnosis, treatment, and regulatory issues. *Exerc Sport Sci Rev.* 2002;30(1):1-3.
6. Rundell KW, Jenkinson DM. Exercise-induced bronchospasm in the elite athlete. *Sports Med.* 2002;32(9):583-600.
7. Rundell KW, Im J, Mayers LB, et al. Self-reported symptoms and exercise-induced asthma in the elite athlete. *Med Sci Sports Exerc.* 2001;33(2):208-13.
8. Mansournia MA, Jamali M, Mansournia N, et al. Exercise-induced bronchospasm among students of Tehran University of

- Medical Sciences in 2004. Allergy Asthma Proc. 2007;28(3):348-52.
9. Sudhir P, Prasad CE. Prevalence of exercise-induced bronchospasm in schoolchildren: an urban-rural comparison. *J Tropical Pediatr.* 2003; 49(2):104-8.
 10. Ng'ang'a LW, Odhiambo JA, Mungai MW, et al. Prevalence of exercise induced bronchospasm in Kenyan school children: an urban-rural comparison. *Thorax.* 1998;53(11):919-26.
 11. Ziaee V, Yousefi A, Movahedi M, et al. The prevalence of reversible airway obstruction in children soccer players. *Iran J Immunol, Asthma Allergy.* 2007; 6(1):33-6.
 12. Mellion MB, Putukian M, Madden CC. *Sports Medicine Secrets.* Philadelphia: Hanley & Belfus. 2003.
 13. Rupp NT. Diagnosis and management of exercise-induced asthma. *Physician Sports Med.* 1996;24(1):77-87.
 14. Voy RO. The U.S. Olympic Committee experience with exercise-induced bronchospasm, 1984. *Med Sci Sports Exerc* 1986;18(3):328-30.
 15. De Baets FD, Bodart E, Dramaix- Wilmet M, et al. Exercise induced respiratory symptoms are poor predictors of bronchoconstriction. *Pediatr Pulmonol.* 2005;39(4):301-5.
 16. Rupp NT, Brudno DS, and Guill MF. The value of screening for risk of exercise-induced asthma in high school athletes. *Ann Allergy.* 1993;70(4):339-342.
 17. Sidiropoulou M, Tsimaras V, Fotiadou E, et al. Exercise-induced asthma in soccer players aged from 8 to 13 years. *Pneumologie.* 2005;59(4):238-43.
 18. Sano F, Solé D, Naspitz CK. Prevalence and characteristics of exercise-induced asthma in children. *Pediatr Allergy Immunol.* 1998;9(4):181-5.
 19. Weiler JM, Bonini S, Coifman R, et al. American Academy of Allergy, Asthma & Immunology Work Group report: exercise-induced asthma. *J Allergy Clin Immunol.* 2007;119(6):1349-58.
 20. Sallaoui R, Chamari K, Chtara M, et al. Asthma in Tunisian elite athletes. *Int J Sports Med.* 2007;28(7):571-5.
 21. Belcher NG, O'Hickey S, Arm JP, et al. Pathogenetic mechanisms of exercise-induced asthma and the refractory period. *New Engl Reg Allerg Proceedings.* 1988;9(3):199-201.