Spirometric Airflow Obstruction in Bangkok School Children: Prevalence and Risk Factors

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Objective: *Determine the prevalence of airflow obstruction in schoolchildren in Bangkok and identify its risk factors.*
Material and Method: *Schoolchildren, aged 6 to 18 years, were randomly selected from six schools in central Bangkok. Parents of the children completed a questionnaire. Standard spirometry was performed. Children were classified as having airflow obstruction if FEV_1/FVC ratio was < 0.8. Children with FEV_1/FVC ratio ≥ 0.8, matched by sex, age, weight, and height, were randomly selected and classified as having no airflow obstruction. Risk factors were identified by univariate and multivariate analyses.*
Results: *Among 1,065 children assessed by spirometry, 43 (4%) demonstrated airflow obstruction. Only three factors including wheezing apart from cold in the past 12 months (OR, 12.82; 95% CI, 1.3-126.5), family history of allergic rhinitis (OR, 2.54; 95% CI, 1.21-5.32), and starting infant formula since birth (OR, 2.47; 95% CI, 1.21-5.04) were shown to be significant risk factors associated with airflow obstruction.*
Conclusion: *The prevalence of airflow obstruction in schoolchildren is lower than those reported in most adult studies. Asthma and family history of allergic rhinitis are important risk factors associated with airflow obstruction. Exclusively breastfeeding since birth might be another helpful measure to prevent the development of airflow obstruction in children.*

Keywords: *Airflow obstruction, Spirometry, Children, Asthma, Allergy, Breastfeeding*

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Calculation of the burden of all respiratory diseases combined can be made from published reports in 2006. They indicate that respiratory diseases account for 15% of deaths in low-middle income countries and 14% in high-income countries, second only to cardiovascular diseases. Among the respiratory diseases, chronic airflow obstruction accounts for 17%[1]. The airflow obstruction refers to diseases that cause reduced pulmonary function related to airway pathology and includes both fixed airflow obstruction (as in chronic obstructive pulmonary disease (COPD) and bronchiectasis) and variable airflow obstruction (as in asthma)[1].

The forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) obtained from spirometry are commonly used to evaluate lung function. FVC is the maximal volume of air exhaled with a maximally forced effort from a position of full inspiration. FEV_1 is the maximal volume of air exhaled in the first second of FVC. The FEV_1/FVC ratio is the most important parameter for detecting airflow limitation in diseases like asthma and COPD. An obstruction of the airway will decelerate expiration and is characterized by decreased FEV_1/FVC ratio[2]. In adults, the prevalence of airflow obstruction confirmed by spirometry in Western countries varied from four to 11%[3,4]. So far, there is limited information on the prevalence of airflow obstruction as demonstrated by lung function test in children. The estimated prevalence based only on asthma symptoms in children, aged 13 to 14 years, ranged from 4.4% in Eastern Europe, 4.5% in South-East Asia, to 25.9% in Oceania[5].

The prevalence of chronic airflow obstruction is reported to be increasing particularly among children and elderly people[6]. If airflow obstruction could be

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detected earlier or contributing risk factors could be identified the patients might have less morbidity and sequaelae. The objective of the present study was to determine the prevalence of airflow obstruction assessed by standard spirometry and identify risk factors affecting airflow obstruction among asymptomatic schoolchildren in Bangkok, Thailand.

Material and Method

Study population

This is a cross-sectional survey conducted between October 2010 and May 2011 in six schools in Bangkok metropolitan area. The authors randomly recruited school children aged 6 to 18 years. The study protocol was approved by the ethics committee of Lerdsin General Hospital. Informed written consent was obtained from parents. Questionnaires were sent and distributed to parents of the children.

Questionnaire

The obtained demographic data obtained included age, sex, race, birth weight, type of delivery, number of siblings, paternal and maternal age and education level, breast feeding, duration of breast feeding, bottle feeding, age that the child started bottle feeding, socioeconomic status. Environmental data included exposure to indoor allergens, type of fuel used at home, active and passive smoking, and exposure to traffic-related and industrial factory air pollution. Health data included any diseases diagnosed by physicians, respiratory symptoms, and medications over the last 12 months, illnesses, respiratory symptoms, and medications used over the last four weeks.

Anthropometric measurements and spirometry

Body weights and heights measurement were made with shoes removed and the children wearing lightweight school uniforms. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$.

Spirometry was performed by well-trained site nurses, using standardized equipment (Jaeger pneumotach spirometer, model: 97342, Hoechberg, Germany) that meets or exceeds the minimum performance recommendations of the American Thoracic Society[7]. Only data collected from acceptable and reproducible spirometric maneuvers according to the American Thoracic Society/European Respiratory Society criteria[7] were included in the analysis. A ratio of FEV_1 to FVC less than 80% was considered to demonstrate airflow obstruction[2,8].

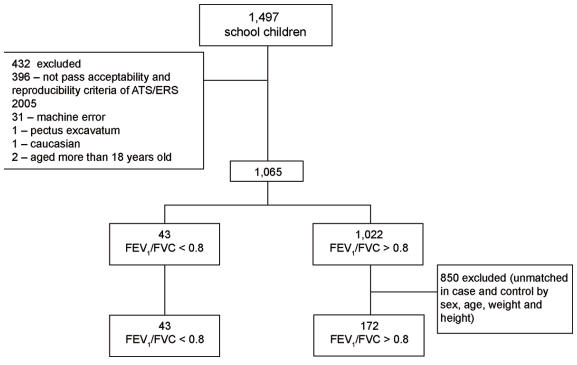
Statistical analyses

Data were recorded by double entry using Access Microsoft software. Statistical analysis was conducted using the SPSS 18.0 software. Values were presented as mean (SD) for continuous variables and proportion or percentage for categorical variables. Children were classified as having airflow obstruction if FEV_1/FVC ratio was < 0.8. Children with FEV_1/FVC ratio ≥ 0.8, matched by sex, age, weight, and height, were randomly selected and classified as having no airflow obstruction. The authors used the unpaired student t-test to compare continuous variables and the λ^2 test for categorical variables. For risk factor analysis, statistically significant factors for airflow obstruction derived from univariate analysis with p-values < 0.05 were selected for multivariate analysis. The outcome was modeled using multiple logistic regressions and presented the results as odds ratios with 95% confidence interval. For all tests, $p < 0.05$ was required for statistical significance.

Results

Parents of 1,497 (89%) children of the randomly selected 1,682 students agreed to participate in the present study and completed the questionnaires. Overall, 45 (3.1%) children reported to have physician diagnosed asthma, 60 (4%) having wheezing apart from cold in the past 12 months, 1,034 (69%) having sneezing, runny nose or nasal congestion in the past 12 months.

Among children who were eligible for spirometry, 1,432 were excluded due to multiple reasons as shown in Fig. 1. Of the remaining 1,065



ATS = American Thoracic Society; ERS = European Respiratory Society; FEV_1 = forced expiratory volume in 1 second; FVC = forced vital capacity

Fig. 1 Flow diagram of the study population

children, 43 (4%) demonstrated airflow obstruction as defined by $FEV_1/FVC < 0.8$. A control group, matched by sex, age, weight and height, was randomly selected from 1,022 children with $FEV_1/FVC \geq 0.8$. The ratio of case to control was 1 to 4. Their demographic and baseline characteristics are shown in Table 1. As expected, children with and without airflow obstruction did not differ in age, sex, weight, height, body mass index and parents' education levels. The group of airflow obstruction had significantly lower FEV_1/FVC ratio as well as $FEF_{25-75\%}$.

From initial univariate analyses (Table 2), significant risk factors associated with airflow obstruction were starting infant formula since birth ($p = 0.011$), starting infant formula before three months of age ($p = 0.045$), family history of allergic rhinitis ($p = 0.012$), sneezing, runny nose or congestion in the past 12 months ($p = 0.038$), and wheezing apart from a cold in the past 12 months ($p = 0.026$).

Multivariate analyses (Table 3) indicated that only three factors including wheezing apart from a cold in the past 12 months, family history of allergic rhinitis and starting infant formula since birth were significant risk factors associated with airflow obstruction.

Discussion

The present study shows that the prevalence of airflow obstruction assessed by standard spirometry is 4% in asymptomatic schoolchildren. Significant risk factors associated with airflow obstruction are wheezing apart from a cold in the past 12 months, family history of allergic rhinitis and starting infant formula since birth. Neither environmental factors, infections nor second-hand cigarette smoking are shown to be statistically significant risk factors.

Because many lung diseases may result in reduced FEV_1, a useful assessment of airflow limitation is the ratio of FEV_1/FVC. The FEV_1/FVC ratio is normally greater than 0.75 to 0.8, and possibly greater than 0.9 in children[9]. In this present study, the authors recruited only asymptomatic children without any signs and symptoms of lower airway obstruction so we selected 0.8 as an arbitrary cut-off number to better screen airflow obstruction.

The prevalence of airflow obstruction in our Thai school children assessed by spirometry is similar to that found in American Indian youths[10] and comparable to those reported in a general adult population in Denmark and Norway[4,11,12] but lower than those reported in adults living in Italy, USA

Table 1. Demographic and baseline characteristics of 43 children with airflow obstruction and 172 control children[#]

	With airflow obstruction (n = 43)	Without airflow obstruction (n = 172)	p-value
Age (y)	13.4 ± 3.2	13.3 ± 3.4	0.931
Male	16 (37.2)	74 (43.0)	0.489
Weight (kg)	50.3 ± 16.5	50.8 ± 16.6	0.883
Height (cm)	152.6 ± 15.5	152.2 ± 16.3	0.890
Body mass index*	21.0 ± 4.4	21.2 ± 4.2	0.828
Highest level of maternal education			
Primary school	7 (16.3)	17 (9.9)	0.417
High school	21 (48.8)	82 (47.7)	
College	15 (34.9)	73 (42.4)	
Highest level of paternal education			
Primary school	4 (9.3)	29 (16.9)	0.407
High school	20 (46.5)	80 (46.5)	
College	19 (44.2)	63 (36.6)	
Spirometry			
FVC (L)	3.3 ± 1.1	3.0 ± 1.1	0.120
FEV_1 (L)	2.4 ± 0.8	2.7 ± 1.0	0.057
FEV_1/FVC ratio (%)	74.5 ± 10.7	91.2 ± 4.7	<0.001
$FEF_{25-75\%}$ (L/sec)	2.0 ± 0.8	3.5 ± 1.3	<0.001

[#] Categorical values are provided as number (percentage) and continuous values as mean ± SD unless specified otherwise

* Calculated as the weight in kilograms devided by height in meters squared

Table 2. Univariate analyses of factors obtained from questionnaires possibly associated with airflow obstruction

	With airflow obstruction (n = 43)	Without airflow obstruction (n = 172)	p-value
Birth condition			
Prematurity	2 (4.7)	7 (4.1)	1.000
Cesarean Section	20 (46.5)	73 (42.4)	0.630
Oxygen therapy in neonatal period	5 (12.5)	9 (5.6)	0.161
Birth weight < 2,500 gram	8 (18.6)	24 (13.1)	0.356
Breast fed < 3 months	19 (44.2)	82 (47.7)	0.682
Start infant formula since birth	17 (39.5)	36 (20.9)	0.011*
Start infant formula before 3 months	25 (59.5)	72 (42.4)	0.045*
Family history of			
Asthma	2 (4.7)	11 (6.4)	1.000
Allergic rhinitis	15 (34.9)	30 (17.4)	0.012*
Atopic dermatitis	5 (11.6)	11 (6.4)	0.325
Diagnosis by physicians			
Asthma	0 (0)	3 (1.7)	0.613
Allergic rhinitis	8 (18.6)	23 (13.4)	0.382
Respiratory symptoms in the past 12 months			
Sneezing, runny nose or nasal congestion disturbing daily life	17 (39.5)	36 (20.9)	0.038*
Wheezing apart from cold	3 (7)	1 (0.6)	0.026*
Snoring	3 (7)	13 (7.6)	1.000
Any respiratory illnesses in the past 4 weeks	18 (41.9)	94 (54.7)	0.133
With fever	2 (11.1)	26 (27.7)	0.233
Antibiotic usage	8 (44.4)	35 (37.2)	0.564
Smoking			
Smoker	1 (2.3)	0 (0)	0.200
Paternal smoker	17 (39.5)	62 (36)	0.671
Maternal smoker	0 (0)	2 (1.2)	1.000
Home environment			
Heavy traffic outside	10 (23.3)	56 (32.6)	0.237
Closed to industrial factory	4 (9.3)	32 (18.6)	0.144
Air-conditioned bedroom	10 (23.3)	39 (22.7)	0.935

Values are provided as number (percentage)
* p-value < 0.05 was considered statistically significant

Table 3. Multivariate analyses of factors significantly associated with airflow obstruction

	Odd ratios	95% confidence interval	p-value
Wheezing apart from cold in the past 12 months	12.82	1.30-126.54	0.024
Family history of allergic rhinitis	2.54	1.21-5.32	0.035
Start infant formula since birth	2.47	1.21-5.04	0.008

and Latin America[3,13,14]. However, all of the studies conducted in adults used the different definition of airflow obstruction as FEV_1/FVC ratio of less than 0.7 and mainly focused on the airflow obstruction associated with COPD. In contrast to adults, COPD is rare in children, which may explain why the prevalence of airflow obstruction found in the present study is lower than those reports from adult populations. In general practice low FEV_1/FVC ratio in children is most likely due to asthma and other relatively uncommon disorders associated with diffuse lower airway inflammation such as bronchiectasis,

bronchiolitis obliterans, primary ciliary dyskinesia, and cystic fibrosis[15].

The presence of wheezing apart from a cold in the past 12 months is the most important risk factor associated with airflow obstruction found in the present study. This question was modified from the questionnaire of the International Study of Asthma and Allergies in childhood (ISAAC)[16] which has been mostly used as the indicator of asthma in order to compute and compare prevalence of asthma changing with time[17] and between countries[18,19]. The authors' finding supports that asthma plays a major role in airflow obstruction in children. In addition, the prevalence of asthma in our 1,497 children as defined by this question was found to be only 4%, which is lower than other previous surveys conducted in Thai children[16,20-22]. The reason of lower prevalence of asthma in the present study is not clear. It might represent the difference in age groups. In the present study, the authors recruited a wider age range, 6 to 18 years, while the other survey selected only two narrow age groups, 6 to 7 years and 13 to 14 years. In addition, the authors used only written but not video questionnaires. Another reason may be due to the difference in selected area of the study, socioeconomic status, and perhaps demographic background of the present study population.

Family history of allergic rhinitis, which was found to be another significant risk factor, supports the previous studies showing an association between allergy and airflow obstruction. In adult subjects, total serum IgE, which is a biomarker of allergy, has been related to reduce pulmonary function especially obstructive lung disease[23,24]. It is evident that increased IgE and the change or impairment of lymphocyte-cytokine activity found in allergic process mainly contributes to airway inflammation[25]. A study conducted in children also found a correlation between duration of isolated allergic rhinitis with the reductions in FEV_1 and forced expiratory flow at 25% and 75% of the pulmonary volume ($FEF_{25-75\%}$)[26]. Similarly, children with atopy to house dust mite or cat were found to have impaired lung function growth, as assessed by spirometry, from 9-15 years[27].

The authors found that starting infant formula since birth was a risk factor to the development of airflow obstruction in children. Additionally, schoolchildren who used to be fed with infant formula before three months were more likely to have spirometric airflow obstruction. The authors' observation implies that exclusively breast feeding after birth for at least three months may reduce risk of airflow obstruction that is in agreement with several previous studies concerning breastfeeding after birth and lung function in schoolchildren. Kull et al similarly reported reduced risk of asthma and better lung function at the age of eight years as measured by peak flow meter in children exclusively breast-fed for four months or longer[28]. Another study by Nagel et al conducted in 20 countries also reported less wheezing and higher predicted FEV_1 in breastfed children aged eight to 12 years in affluent countries[29]. Likewise Ogbuana et al found that breastfeeding for at least four months enhanced lung function in children at age 10 years as demonstrated by significant increases in FVC, FEV_1, and peak flow when compared to those who were not breastfed[30]. Therefore, the authors would like to emphasize an avoidance of formula feeding since birth and encourage exclusive breastfeeding for at least the first three months of life.

One limitation of the present study is that we did not give bronchodilators and repeat spirometry so we could not describe whether the airflow obstruction was reversible. Therefore, the authors could not provide a more valid measurement of asthma prevalence[9]. Furthermore, only written questionnaire to evaluate risk factors to airflow obstruction were used. Some potential risk factors were determined only by yes or no questions that asked whether the child exposed to that specific pollution or allergen such as traffic, parental cigarette smoking, cats, or dogs. The degree of exposure may be too low and may be one reason to explain why the association between these factors and airflow obstruction in the presented children could not be demonstrated.

In conclusion, the prevalence of airflow obstruction as defined by $FEV_1/FVC < 0.8$ is 4% in asymptomatic Bangkok schoolchildren. Asthma as defined by the presence of wheeze apart from cold over the last 12 months and family history of allergic rhinitis are important risk factors associated with airflow obstruction. Exclusive breastfeeding might be a helpful measure to prevent the development of airflow obstruction.

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Potential conflicts of interest

None.

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อุบัติการณ์และปัจจัยที่มีผลต่อภาวะอุดกั้นทางเดินหายใจ ซึ่งวัดโดยการทดสอบสมรรถภาพปอดในเด็กนักเรียน กรุงเทพมหานคร

สุพิตรา สุวรรณพรหมา, จรูญ บุญลาภทวีโชค, อุมาพร อุดมทรัพยากุล, อรุณวรรณ พฤทธิพันธุ์

วัตถุประสงค์: *เพื่อหาอุบัติการณ์และปัจจัยที่มีผลต่อภาวะการอุดกั้นทางเดินหายใจในเด็กนักเรียนในกรุงเทพมหานคร*
วัสดุและวิธีการ: *เด็กนักเรียนอายุ 6-18 ปี ถูกสุ่มตัวอย่างจากโรงเรียน 6 แห่ง ในกรุงเทพมหานคร ที่เข้าร่วมโครงการอย่างสมัครใจ ตอบแบบสอบถามโดยผู้ปกครองและทดสอบสมรรถภาพปอดด้วยเครื่อง spirometry เด็กนักเรียนจะถูกจัดอยู่ในกลุ่มที่มีภาวะทางเดินหายใจอุดกั้น เมื่อค่า $FEV_1 / FVC < 0.8$ เทียบกับกลุ่มเด็กปกติที่มีค่า $FEV_1 / FVC \geq 0.8$ ซึ่งมีเพศ, อายุ, น้ำหนักตัว และส่วนสูงใกล้เคียงกัน นำมาหาปัจจัยเสี่ยงโดยวิธีการทางสถิติ (univariate and multivariate analysis)*
ผลการศึกษา: *ในเด็กซึ่งทำการทดสอบสมรรถภาพปอดโดยเครื่อง spirometry ทั้งหมด 1,065 ราย พบว่า 43 ราย (4%) มีภาวะทางเดินหายใจอุดกั้น และพบปัจจัยเสี่ยงที่เกี่ยวข้องกับภาวะนี้ 3 อย่าง ได้แก่ ประวัติการหายใจ เสียงวี้ดขณะไม่เป็นหวัดในช่วง 1 ปีที่ผ่านมา (OR 12.82; 95% CI 1.3-126.5) ครอบครัวมีประวัติโรคจมูกอักเสบภูมิแพ้ (OR 2.54; 95% CI 1.21-5.32) และประวัติการเริ่มกินนมผสมตั้งแต่แรกคลอด (OR 2.47; 95% CI 1.21-5.04)*
สรุป: *อุบัติการณ์ของภาวะทางเดินหายใจอุดกั้นในเด็กนักเรียนในการศึกษาครั้งนี้มีค่าต่ำกว่าการศึกษาอื่น ๆ ในผู้ใหญ่ โรคหอบหืดและประวัติโรคจมูกอักเสบภูมิแพ้ในครอบครัว เป็นปัจจัยเสี่ยงสำคัญที่เกี่ยวข้องกับภาวะทางเดินหายใจอุดกั้น การให้นมแม่อย่างเดียวตั้งแต่แรกคลอดน่าจะช่วยป้องกันการเกิดภาวะทางเดินหายใจอุดกั้นในเด็กได้*