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Lung Function and Symptom Perception in Children With Asthma and Their Parents

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Summary. A large proportion of children with asthma are managed without recourse to specialized care, and treatment decisions are based solely on symptoms as reported by the children and their parents. We investigated 90 school-age children with the diagnosis of asthma and their accompanying parent to evaluate whether we can obtain better information by using three different means of asking for asthma symptoms: a questionnaire for children ($QSR_{children}$), "smilies," and a visual analogue scale for children ($VAS_{children}$). Furthermore, we analyzed the relationship between these symptom reports and lung function results. Finally, we attempted to determine whether performing a lung function test contributes relevant information toward improving asthma management.

Multiple linear regression adjusted for age and gender showed a significant relationship between VAS for children and forced expiratory volume in 1 sec (FEV_1) ($P = 0.047$) and maximal expiratory flow at 50% of forced vital capacity (MEF_{50}) ($P = 0.037$). Neither age, gender, QSR for children, "smilies for children" nor all the parents' scores showed a significant association with lung function measurement in the regression model. Subgroup analysis with Spearman's rank correlation coefficients by age group revealed significant correlation in children <10 years between VAS for children, QSR for parents, smilies for parents, and the lung function parameters FEV_1, and MEF_{50}. Above age 10 years there was no correlation at all, with the accuracy correlation ranging from −0.04 to +0.21.

Our data demonstrate that reported symptoms do not reliably correlate with lung function results in asthmatic children and the childrens' parents, and correlation is dependent on the instrument used for symptom evaluation. In children, the VAS, and in parents, the QSR were the most valuable means of obtaining best information on asthma symptoms. This underlines the importance of supplementing information on asthma symptoms with lung function measurements to more reliably assess the severity of asthma. **Pediatr Pulmonol. 2003; 35:23–28.** © 2003 Wiley-Liss, Inc.

Key words: children; asthma; symptom perception; lung function.

INTRODUCTION

Asthma management guidelines aim for optimum control of asthma, including normal activity, minimal or no symptoms, no exacerbation, little need for β_2-agonists, and normal lung function.[1,2] For this reason, children's and parents' reports on asthma symptoms are important in staging and managing pediatric asthma. Breathlessness, chest tightness, cough, and wheeze, as well as exercise-induced symptoms, are helpful in guiding clinicians in their treatment decisions. However, it is known that many children and their parents do not adequately perceive asthma symptoms. Physical findings appear to be inadequate for assessing obstruction in asthma, and considerable obstruction may be present despite a normal physical examination.[3] Peak expiratory flow rates (PEFR) monitored at home and an asthma diary are useful tools in selected patients, but there are major limitations to their widespread use.[4] Spirometry as an objective measurement of airway obstruction is not performed regularly by physicians treating children with asthma. According to the Asthma Insights and Reality Europe (AIRE) Study,[5] only 29% of asthmatic children reported that their doctor had given them a lung function test in the past year, and over 50% of children with asthma had never undergone a lung function test. A large proportion of children with asthma are managed without recourse to specialized care and without lung function measurements, and physicians base treatment decisions on symptom reports and auscultation.

This study compared subjective information for asthma symptoms in a group of children with the diagnosis of

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asthma and their parents with objective measurements of airway obstruction. The purpose was, firstly, to evaluate whether we could improve information by using three different means of asking for asthma symptoms and to determine the most useful symptom score. Secondly, we sought to characterize the relationship between children's and parents' symptom reports and lung function results. We wanted to determine whether it is appropriate to treat children with asthma on the basis of symptom reports alone, or whether performing a lung function test contributes relevant information toward improving asthma management. Which criterion is the best to assess asthma severity is a matter of dispute, and so far there is no golden standard, but as treatment differs between mild and severe asthma, it is important to assess asthma severity as reliably as possible.

MATERIALS AND METHODS

In an outpatient clinic for childhood asthma, we investigated 90 children (29 girls, 61 boys) between the ages of 6–16 years (average, 10.2 years) with the diagnosis of asthma, who had been referred for further investigation or regular follow-up, and their accompanying parent (n = 80). The inclusion criteria for enrollment in the study were the diagnosis of asthma, a prescription for daily inhalation therapy, and an age of at least 6 years. The minimum age of 6 years was chosen to ensure that children were able to perform reproducible lung function tests. Asthma was defined as a history of recurrent wheezing and/or an increase of 12% or more in forced expiratory volume in 1 sec (FEV_1) after salbutamol inhalation.

Measurement of Symptom Scores

After parental consent and child assent, the children and their parents were asked whether the asthma had been stable during the last 3 days, including the day of examination, and, if yes, to rate the asthma symptoms. Children with acute asthma exacerbation were not included in the study. Children and parents were interviewed separately, and made their ratings without the other being present.

Questionnaire Symptom Report (QSR), Maximum Rating = 50 Points

The questionnaire consisted of five questions evaluating wheezing, night disturbance due to cough/wheeze, chronic cough, breathlessness, and exercise-induced symptoms. Possible answers were "yes" or "no." Every "yes" was given 10 points, and every "no," 0 points.

ABBREVIATIONS	
FEV_1	Forced expiratory volume in 1 sec
MEF_{50}	Maximal expiratory flow at 50% of forced vital capacity
PEFR	Peak expiratory flow rate
QSR	Questionnaire symptom report
VAS	Visual analogue scale

"Smilies," Maximum Rating = 20 Points

The child was asked to choose between three "smilies," depending on the degree of asthma "felt" during the previous 3 days (none = 0, medium = 10, bad = 20 points).

Visual Analogue Scale (VAS), Maximum Rating = 30 Points

The VAS consisted of three rulers asking for breathlessness, cough/wheeze, and exercise-induced symptoms. The limits of each ruler were labeled 0 for *no* symptoms at the left end, and 10 for *most severe* symptoms at the right end. With a movable marker, the child could mark any point on the 10-cm line which best described his/her situation. No interval markers were visible on the line.

The child's accompanying parent was also asked to give subjective scores for the severity of symptoms she/he felt her/his child had experienced in the previous 3 days.

Measurement of Lung Function

After the symptom reports, a physical examination and lung function measurement were performed.

Flow volume curves were measured with a Jaeger Spirometer (Würzburg, Germany). The lung function maneuver was performed according to American Thoracic Society (ATS) standards. Values were expressed as percentage predicted of normal for height and sex.[6] $FEV_1 \geq 80\%$ predicted and $MEF_{50} \geq 65\%$ predicted were considered to be within normal range.[7,8]

Statistical Analysis

Analyses were conducted to account for gender, pulmonary function status, and age. Age categories (<10 years and ≥10 years) were established before analysis. At age 10 years, Austrian children switch from primary to secondary school, and this switch is usually accompanied by more independence from home. Since symptom scores were not normally distributed, the Mann-Whitney test was used to compare scores between the various groups in Table 1.

Multiple linear regression analysis was used to adjust for age and gender effects in order to examine the relationship between the measures of lung function and asthma symptom scores. QSR and "smilie" scores were included in the regression models as indicator variables. Spearman's rank correlation coefficients were calculated to show age- and sex-related subgroup correlations (−1 indicates the highest possible relationship, 0 indicates no correlation between subjective and objective assessments). $P < 0.05$ was considered statistically significant.

TABLE 1—Symptom Scores (Mean, SD) in Relation to Gender, Age, and Lung Function

	Boys	Girls	<10 years	≥10 years	$FEV_1 \geq 80\%$	$FEV_1 < 80\%$	$MEF_{50} \geq 65\%$	$MEF_{50} < 65\%$
$N_{children}$	61	29	43	47	76	14	54	36
$FEV_{1\%\ predicted}$								
Mean (SD)	97.2 (15.7)	92.3 (16.4)	97.5 (16.1)	93.8 (15.9)	100.4 (12.1)	69.3 (6.7)	103.9 (12.2)	83.1 (12.7)
95% CI	93–101	86–99	92–102	89–98	98–103	65–73	101–107	79–87
$MEF_{50\%\ predicted}$								
Mean (SD)	71 (20.9)	71.2 (24.9)	71.2 (23.4)	70.9 (21.2)	76.2 (19.8)	43.2 (10.3)	84.5 (17.5)	50.9 (9.7)
95% CI	66–76	62–81	64–78	65–77	72–81	37–49	80–89	48–54
$QSR_{children}$								
Mean (SD)	11.1 (11.5)	14.4 (12.4)	13.4 (13.7)	11.0 (9.8)	11.9 (11.6)	13.5 (13.3)	11.6 (12.2)	13.0 (11.4)
Median	10	10	10	10	10	15	10	10
$Smilie_{children}$								
Mean (SD)	4.9 (5.2)	7 (6.4)	6.6 (5.6)	4.7 (5.7)	5.3 (5.6)	7.1 (6.1)	5.6 (5.9)	5.5 (5.5)
Median	0	10	10	0	5	10	5	10
$VAS_{children}$								
Mean (SD)	6.2 (5.7)	8.8 (7.9)	8.0 (7.1)	6.3 (6.0)	6.5 (6.1)	10.2 (8.5)	6.0 (6.4)	8.6 (6.7)*
Median	5	7	8	5	5.5	12	5	7
$N_{parents}$	54	26	43	37	70	10	50	30
$QSR_{parents}$								
Mean (SD)	9.2 (9.8)	13.6 (12.8)	12.7 (11.6)	8.1 (9.6)	9.5 (10.2)	18 (13.1)*	9.8 (11.1)	12 (10.6)
Median	10	10	10	10	10	20	10	10
$Smilie_{parents}$								
Mean (SD)	6.8 (3.3)	7.8 (4.3)	7.4 (3.7)	6.8 (3.6)	6.8 (3.3)	9.5 (4.9)*	6.8 (3.5)	7.7 (3.9)
Median	5	10	10	5	5	10	5	10
$VAS_{parents}$								
Mean (SD)	7.0 (5.7)	9.7 (6.7)	8.6 (6.9)	7.1 (4.9)	7.3 (5.5)	12.2 (8.6)	7.9 (5.9)	8.0 (6.4)
Median	7	9.5	8	7	7	11.5	8	7

*$P < 0.05$.

RESULTS

Lung Function

FEV_1 ranged from 58–134% predicted (mean, 95.6; 95% confidence interval (CI), 92–99), and MEF_{50} ranged from 28–145% predicted (mean, 71.1; 95% CI, 66–76); 53 patients had lung function values within the normal range, 14 children had $FEV_1 < 80\%$ predicted, and 36 children had $MEF_{50} < 65\%$ predicted. No statistically significant difference was observed in lung function between boys and girls, or between the younger and older children.

Symptom Scores

Of the 53 children with lung function values within normal range, only 8 children and 3 parents reported no asthma symptoms. The main complaints were exercise-induced symptoms, followed by wheezing.

Symptom scores in relationship to gender, age, and lung function are shown in Table 1. Despite no difference in lung function, girls tended to report higher symptom scores than boys, as did children under age 10 years, but this did not reach statistical significance. Children with reduced lung function also showed a tendency to report higher scores than did children with normal lung function. Statistical significance was reached for the VAS for children ($VAS_{children}$) when MEF_{50} was low. Also, significantly higher scores were found for the QSR for parents ($QSR_{parents}$) and smilies for parents ($smilies_{parents}$) when their children's FEV_1 was impaired.

Relationship Between Lung Function and Symptom Scores

When tested with multiple linear regression adjusted for age and gender, a significant relationship was seen between $VAS_{children}$ and the lung function parameters FEV_1 ($P = 0.047$) and MEF_{50} ($P = 0.037$). Age, gender, $QSR_{children}$, $smilies_{children}$, and all parental scores showed no significant association with lung function measurement in the regression model.

However, subgroup analysis with Spearman's rank correlation coefficients by age group revealed significant correlation in children <10 years between $VAS_{children}$ and FEV_1 ($r = -0.33$) and MEF_{50} ($r = -0.37$), $P < 0.05$; between $QSR_{parents}$ and FEV_1 ($r = -0.36$) and MEF_{50} ($r = -0.39$), $P < 0.05$; and between $smilies_{parents}$ and FEV_1 ($r = -0.39$) and MEF_{50} ($r = -0.52$), $P < 0.01$. Above age 10 years there was no correlation at all, with the accuracy correlation ranging from −0.04 to +0.21.

Subgroup analysis by lung function status revealed a significant correlation between $QSR_{children}$ and FEV_1 ($r = -0.75$, $P < 0.01$) when the children's FEV_1 was

<80% predicted. No significant correlation was found between the parent's scoring and the children's lung function status.

DISCUSSION

Most surveys of asthma symptom perception in children have been conducted under induced bronchoconstriction with methacholine or histamine, during an exercise test, by adding resistive loads, or during an asthma exacerbation.[9–13]

The present study adds information about children's and parents' asthma perception during a regular consultation in an outpatient clinic, where children with asthma are referred for further investigation or regular follow-up. Our data demonstrate that reported symptoms do not reliably correlate with lung function results in asthmatic children and the childrens' parents, and correlation is dependent on the instrument used for symptom evaluation. The VAS clearly provided the best information on asthma symptoms from children. QSR and ''smilies'' gave the most reliable information from parents, but only if their child was younger than 10 years.

Fifty-three children had lung function values within normal range,[7,8] but only 8 of these children and 3 of the parents reported no asthma symptoms. There are two possible explanations for these findings. One is that these children and parents overestimated the asthma. The other is that expressing lung function as percent predicted may not adequately express what is normal for the individual child, and considerable airway obstruction might be present despite having normal percent predicted values.

Grading of asthma severity is largely based on symptom reports, although it is known that many children and their parents do not adequately perceive symptoms. For this reason, lung function measurements are a useful adjunct to the history. When the given symptom rating and lung function values are in agreement, assessment of severity is easy. When they are contradictory, one is left wondering which is more reliable, and further investigations are needed. As a first step, a bronchodilator test gives valuable information. If disagreement persists, home recordings of PEFR measurements and symptoms, a drug therapy trial, a challenge test measuring the response to exercise, hypertonic saline, histamine, or metacholine give additional information for assessing the severity of the disease.

What is the role of airway caliber in the assessment of children's asthma? Lung function tests allow the severity of an abnormality to be quantified and the presence of reversible airway obstruction to be determined, and are helpful in guiding optimal treatment of those with more severe disease.[1] Severity and frequency of symptoms have consistently been seen to be associated with a lower level of lung function and a less favorable long-term outcome.[14–21] The majority of children with asthma, however, have mild disease with a good prognosis, and the effect on long-term outcome of early intervention with preventive treatment remains to be defined.[1,22,23] Although symptom reports give important information on asthma severity, many children and their parents are not able to adequately perceive the stage of the disease,[11,13,24,25] and therefore lung function testing may help to assess the severity of the child's asthma more reliably. If no symptoms are reported but lung function is abnormal and the bronchodilator test is positive, then there is clearly underperception. Hypoperceivers may be at risk for undertreatment, the consequence being fatal or near-fatal asthma. On the other hand, significant symptoms may be reported despite normal lung function. This becomes a major problem if this has led to the use of high-dose inhaled steroids, and in that situation, further criteria are required to guide the best treatment. Hyperperceivers are at risk for adverse effects caused by overtreatment, resulting in excessive medication, frequent hospitalization, and unnecessary restrictions in daily life.[26] Interference between emotions and the perception of breathlessness has been discussed as an explanation for the inconsistent perception pattern.[27] Negative emotions directly enhance the magnitude of breathlessness, and psychological factors may modify symptoms.[28,29] Inaccuracy of symptom perception and unreliable symptom reports make it difficult to permit decision-making for long-term asthma management on the basis of symptom reports alone. It has been stated that even symptom score records from diary cards are a poor basis for assessing childhood asthma and should be supplemented with home records of PEFR measurements.[25] Recent publications propose that electronic peak flowmeters should be preferred, because PEFR diaries also seem unreliable.[30,31] Furthermore, PEFR is an insensitive measure of airway caliber and does not reflect all changes in lung function.[32,33] Thus, a normal value does not rule out a significantly small airway narrowing, and spirometry including a bronchodilator test should consequently be part of the routine assessment of patients with asthma.[1,4]

Despite similar lung function, girls tended to report more symptoms than did boys, as did the girls' parents, although this did not reach statistical significance. Explanations are speculative, but biased symptom perception due to worrying, greater susceptibility to their symptoms, or better communication skills might have influenced the girls' reports. Important data are available which focus on whether there is a gender difference in asthma perception in children; however, these data are contradictory. Fritz et al. found that children's perceptual accuracy was not related to age or sex,[24] whereas Gabriels et al.[34] found girls to be more accurate in recognizing their respiratory symptoms. Sennhauser and Kühni,[35] in their large survey of asthma symptoms, observed no significant sex differences

at ages 7 or 12 years, while at age 15 years, a highly significant female preponderance became evident. A recent publication about perception in adults reported that men are less likely than women to report severe asthma symptoms and activity limitations in the presence of airway obstruction.[36]

Parental knowledge about the asthma health status of their children was age-dependent in this study. In the case of children under age 10 years, parents seem to be reasonably informed, with good correlation between parental symptom scores ($QSR_{parents}$, $smilie_{parents}$) and lung function, whereas in children older than 10 years there was no correlation at all. This is in keeping with a recent publication by Guyatt et al.[37] suggesting that, in general, clinicians will obtain all the information they need from talking with asthmatic children 11–17 years old. Additional parental reports in this age group may be misleading, whereas the reverse was seen for younger children.

Our data demonstrate that the use of a VAS improved information about asthma symptoms in all children, correlating significantly with both FEV_1 and MEF_{50}, and was particularly valuable in children under age 10 years. It might be easier for children to rate their symptoms than to verbalize them. Fritz et al.[38] also stated that a VAS was easily understood by children and was a useful tool in improving children's perceptual ability. For parents, none of the scores was particularly useful. If any, the QSR gave the most reliable information on asthma symptoms.

In summary, our data demonstrate that reported symptoms do not reliably correlate with lung function results in asthmatic children and the childrens' parents. This emphasizes the importance of using objective measures of lung function as an additional tool in assessing asthma severity more reliably. In children, the VAS, and in parents, the QSR were the most valuable means of obtaining the best information on asthma symptoms.

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