Clinical significance of cough and wheeze in the diagnosis of asthma

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Abstract

***Objectives*—(1) To determine the prevalence of cough, wheeze, and breathlessness, both as single symptoms and in combination, in primary schoolchildren and their relation to doctor diagnosed asthma. (2) To identify in areas with different levels of dust pollution whether questionnaire reported 'cough alone' (without wheeze or breathlessness) had similar risk factors to the questionnaire reported triad of 'cough, wheeze, and breathlessness'.**

***Subjects and methods*—Two cross sectional community surveys of primary schoolchildren (5–11 years) were performed in 1991 and 1993. Parent completed questionnaires related to socioeconomic and respiratory factors were distributed through 15 schools in three areas of Merseyside, one of which had a relatively high level of dust pollution. Data were analysed to determine the prevalence of different respiratory symptom patterns. Univariate and multiple logistic regressions were used to investigate the associations between respiratory symptom profiles and potential risk factors.**

***Results*—The proportions of completed questionnaires that were returned were similarly high in both surveys, 92% in 1991 (1872 of 2035) and 87% in 1993 (3746 of 4288). The proportions of children with different respiratory symptom patterns were similar in the two surveys: in 1991, asymptomatic children 70.1% (1109 of 1583), those with cough alone 8.9% (141 of 1583), and children with the symptom triad of cough, wheeze, and breathlessness 8.3% (132 of 1583); the figures for 1993 were 69.5% (2144 of 3083), 9.2% (284 of 3083), and 7.3% (224 of 3083) respectively. The prevalence of doctor diagnosed asthma increased from 17.4% in 1991 to 22.1% in 1993. The symptom of cough alone was associated with going to school in an area of increased air pollution. The symptom triad of cough, wheeze, and breathlessness was associated with reported allergies, familial history of atopy and preterm birth. In 1991, of children with the symptom of cough alone one in eight were diagnosed asthmatic; twice as many doctors made the diagnosis on this basis in 1993.**

***Conclusion*—The respiratory symptom of cough alone and cough, wheeze, and breathlessness represent clinical responses to different specific risk factors. Cough alone was associated with the environmental factors of school in the dust exposed zone and dampness in the home, whereas cough, wheeze, and breathlessness related to allergic history and preterm birth, and may be the best surrogate of asthma. Diagnosis of asthma on the basis of cough alone partly explains the increased prevalence of doctor diagnosed asthma, especially in dust polluted areas.**

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Many studies have reported the prevalence of asthma and of respiratory symptoms in children.[1–5] However, it is difficult to compare the results of different prevalence surveys because study populations have different socioeconomic profiles, environmental risk factors vary with time and between different areas, and the criteria used to define asthma differ. The pattern of respiratory symptoms can vary depending on the magnitude of specific risk factors in the area surveyed. It is necessary to distinguish which symptoms are associated with which risk factors in order to determine which group(s) of symptoms is/are the best surrogate of asthma and therefore estimate the true prevalence of asthma in groups of children with different respiratory symptom patterns.

We have re-examined questionnaire reported data from two cross sectional surveys performed in 1991 and 1993 to assess the possible impact of a dust pollution source on the respiratory health of primary schoolchildren on Merseyside. We previously reported in this population a 60% greater prevalence of excess cough (without wheeze and without breathlessness) in primary schoolchildren living in an area of increased dust pollution compared with other areas.[6] We were uncertain whether this increased reporting of cough alone represented an increase in asthma or whether it was a non-asthmatic response to increased levels of inhaled dust. We hypothesised that the symptom triad of cough with wheeze and breathlessness was likely to represent current symptomatic asthma and also examined questionnaire reported 'ever diagnosed asthma' which is

Table 1 General description of children for both surveys

	1991 (n=1872)	1993 (n=3746)
Mean age (years) (SD)	7.09 (2.0)	7.15 (2.0)
Sex (boy) (%)	51.0	50.2
Doctor diagnosed asthma (%)	17.4	22.1***
% Living in the area of increased air pollution	25.9	25.0
% With wheezing	20.6	21.3
% With breathlessness	12.8	12.7
% With cough	22.8	23.3

Wheezing: severe attack of wheezing at any time. Breathlessness: severe attack of breathlessness at any time. Cough: excess cough in the previous 12 months.
*** $p < 0.001$, compared with 1991. For other variables there was no significant difference between 1991 and 1993.

Table 2 Comparison of the prevalence (%) of respiratory symptom profiles in 1991 and 1993

	1991 (n=1583)*	1993 (n=3083)*
C−W−B−	70.1	69.5
C+W−B−	8.9	9.2
C+W+B+	8.3	7.3
C+W+B−	4.7	4.7
C−W+B−	4.1	5.0
C−W+B+	1.5	1.8
C+W−B+	1.7	1.1
C−W−B+	0.7	1.3

* Number of questionnaires returned with responses for all respiratory variables. C = excess cough in the previous 12 months; B = severe attack of breathlessness at any time; W = severe attack of wheezing at any time; + or − indicates the presence or absence of a symptom. The symptom patterns of cough alone (C+W−B−) and cough, wheeze, and breathlessness (C+W+B+) are more common than one would expect if the symptoms were independent of each other. Log linear analysis shows that there is a strong positive association between wheeze and breathlessness ($\chi^2 = 443$, $p < 0.001$). There is also a positive association between cough and wheeze ($\chi^2 = 197$, $p < 0.001$) and between cough and breathlessness ($\chi^2 = 104$, $p < 0.001$).

often used as a marker of asthma in prevalence studies.

In this paper our objectives were: (1) to determine the prevalence of cough, wheeze, and breathlessness either singly or in combination, (2) to identify whether questionnaire reported cough alone has similar risk factors to the questionnaire reported triad of cough, wheeze, and breathlessness, and (3) to compare the prevalence of doctor diagnosed asthma in children with different symptom patterns.

Subjects and methods

DESIGN

Two cross sectional community based surveys of primary schoolchildren (aged 5–11 years) were performed in 1991 and 1993 in five schools in each of three separate areas in Merseyside. In 1991 every second child on the class register was chosen for the survey (2035), and in 1993 all children in each school were surveyed (4288).

QUESTIONNAIRE

The questionnaire was a modified version of that designed by Clifford *et al*[1] and has been fully described elsewhere.[6] Class teachers distributed and collected parent completed questionnaires which asked questions about parental smoking patterns, and socioeconomic and respiratory variables. Cough, wheeze, and breathlessness were assessed by the questions, 'has your child ever seemed to cough more (or get more coughs) compared to other children?'; 'has your child ever had wheezing (by wheezing I mean noisy breathing with a whistling sound coming from the chest or throat)?'; 'has your child ever been unexpectedly breathless at rest or more breathless than you would expect after exercise (by breathless I mean out of breath or puffed)?' The symptom triad of cough, wheeze, and breathlessness was deduced from positive responses to all three questions.

STATISTICAL METHODS

Two types of analysis were performed. Univariate analysis stratified for single risk factors and multiple logistic regression analysis were used to quantify risk factors associated with respiratory symptom profiles.

Results

The proportions of questionnaires returned were similarly high in both surveys, 1872 of 2035 (92%) in 1991 and 3746 of 4288 (87%) in 1993. Table 1 gives a general description of the study population. More children were diagnosed asthmatic by a doctor in 1993 but there were no differences in the overall prevalence of symptoms between the surveys (table 1).

The proportion of children with no symptoms, with the single symptom of cough, or with cough, wheeze, and breathlessness in combination were also similar in the two surveys (table 2).

In 1993 children with doctor diagnosed asthma were less likely to have the symptom triad of cough, wheeze, and breathlessness (37.7% *v* 45.6%), and more likely to have been labelled as asthmatic without ever having wheezed (29.8% *v* 23.7%) (table 3).

UNIVARIATE STRATIFIED ANALYSIS

A comparison of socioeconomic and maternal factors in 1991 and 1993 for asymptomatic children and those with cough alone and cough, wheeze, and breathlessness is shown in table 4. Univariate analysis showed that respiratory symptoms were significantly associated with renting rather than owning a property ($p<0.05$) and with the reported presence of dampness in the home ($p<0.01$), but not with the presence of smokers in the home or with having been breast fed. The symptom triad of cough, wheeze, and breathlessness was significantly associated with having been born prematurely ($p<0.01$).

Table 3 Proportions of different symptom combinations for children with doctor diagnosed asthma

	1991 (n=237)	1993 (n=533)	Significance level (p value)
Cough, wheeze, and breathlessness (C+W+B+)	45.6	37.7	0.05
Cough or breathlessness with wheeze (C+B−W+ or C−B+W+)	30.7	32.5	0.71
Cough and/or breathlessness without wheeze (C+B+W− or C+B−W− or C−B+W−)	23.7	29.8	0.09

C = excess cough in the previous 12 months; B = severe attack of breathlessness at any time; W = severe attack of wheezing at any time; + or − indicates the presence or absence of a symptom.

Table 4 Frequency of socioeconomic and maternal variables (%) for children with different respiratory symptom profiles

	Respiratory symptom profile		
	Asymptomatic (n=1109)	*Cough (n=141)*	*Cough, wheeze, breathlessness (n=132)*
1991			
Rented accommodation	41.1	49.3	59.7***
Damp home	12.0	22.5**	31.4***
Smoker(s) in household	58.4	66.4	65.0
Preterm birth	12.5	13.7	26.0***
Not breast fed	68.2	66.2	67.9
1993	*(n=2144)*	*(n=284)*	*(n=224)*
Rented accommodation	42.9	54.7***	51.6*
Damp home	14.0	27.7***	30.5***
Smoker(s) in household	58.0	60.6	61.2
Mother smoked during pregnancy	36.0	34.3	35.1
Preterm birth	11.8	11.7	19.4**
Not breast fed	68.1	73.5	65.2

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, compared with asymptomatic children.

Table 5 Health parameters (%) in 1991 and 1993 for children with different respiratory profiles

	Respiratory symptom profile		
	Asymptomatic (n=1109)	*Cough (n=141)*	*Cough, wheeze, breathlessness (n=132)*
1991			
Doctor diagnosed asthma	2.1	10.0	83.1
Allegies (hay fever, eczema)	8.7	13.3	47.3
Prescribed medicines†	4.4	14.9	61.8
Absent from school due to respiratory symptoms for > 6 days/year	0.9	5.7	39.0
Ever admitted to hospital for respiratory symptoms	3.0	25.0	61.0
1993	*(n=2144)*	*(n=284)*	*(n=224)*
Doctor diagnosed asthma	3.0	22.6*	89.9
Allegies (hay fever, eczema)	12.9*	18.8	61.0*
Prescribed medicines†	5.2	22.9	75.1*
Absent from school due to respiratory symptoms for > 6 days/year	1.5	4.6	36.8
Ever admitted to hospital for respiratory symptoms	4.1	25.6	61.4

* $p < 0.05$, compared with 1991.
† 65% of which are antiasthmatic medicines.

In both surveys asymptomatic children were less likely to have doctor diagnosed asthma, allergies, medicines prescribed, admissions to hospital for respiratory symptoms, absenteeism from school (for more than six days) due to respiratory symptoms (all $p<0.01$), compared with children with cough alone or cough, wheeze, and breathlessness (table 5). Children with cough alone had a lower prevalence of each of these ill health indicators when compared with children with cough, wheeze, and breathlessness.

In 1993 the children with cough alone were more likely to have been diagnosed as asthmatic by a doctor ($p<0.05$) and to report problems with allergies. Significantly more children with the symptom triad received prescribed medicines in 1993 ($p<0.05$), although 25% were reported to be receiving no medication. In 1991, 2.1% (23 of 1109) and in 1993, 3.0% (63 of 2144) of asymptomatic children had a history of doctor diagnosed asthma. Although none of these children had current symptoms, 52% in 1991 (12 of 23) and 38% in 1993 (24 of 63) had a cough at some time in life which had been diagnosed as asthma. Reported diagnosis of asthma in other asymptomatic children remains unexplained.

REGRESSION ANALYSIS

Adjusted odds ratios for risk factors were calculated for respiratory symptom profiles by logistic regression in order to control for multiple confounding factors (table 6). Maternal asthma, allergies, and other health problems were strongly associated with cough, wheeze, and breathlessness. Preterm birth and paternal asthma were associated with cough and wheeze. The risk of cough and wheeze decreased with age (more steeply for cough). Of the other risk factors, some were associated with wheeze and some only with cough. Children with environmental risk factors such as going to school in the area of increased dust pollution, dampness in the home and rented accommodation were more likely to have cough alone.

Discussion

PREVALENCE OF RESPIRATORY SYMPTOM PROFILES

Questionnaires are often used in respiratory health surveys, and data collected in this way have been shown to be reproducible.[7 8] Confidence that the information collected is valid is dependent upon response rates, which in this study compared favourably with other reports.[1–5 9]

The two surveys were performed in parallel in the same areas and in the same months (October to December), avoiding variations due to seasonal influences. The prevalence of wheezing, cough, and breathlessness is comparable with previous reports.[4 5 10] The cumulative prevalence of doctor diagnosed asthma is higher than reported elsewhere, although this may be confounded partly by the low social class of the three areas in this study.

Table 6 Logistic regression models for cough, wheeze, and breathlessness for 1993 data; results are odds ratio (95% confidence interval)

	Cough	*Wheeze*	*Breathlessness*
Child has allergies	3.29 (2.50 to 4.33)	4.47 (3.36 to 5.94)	5.26 (3.79 to 7.29)
Maternal asthma	1.67 (1.65 to 2.43)	2.71 (1.87 to 3.93)	2.87 (1.91 to 4.33)
Child has other health problems	1.91 (1.44 to 2.53)	1.82 (1.34 to 2.46)	1.65 (1.10 to 2.46)
Age in years	0.83 (0.78 to 0.88)	0.92 (0.87 to 0.97)	0.99 (0.93 to 1.06)
Preterm birth	1.65 (1.24 to 2.20)	1.46 (1.08 to 2.00)	1.38 (0.95 to 1.99)
Paternal asthma	1.43 (0.96 to 2.12)	1.71 (1.13 to 2.58)	1.25 (0.75 to 2.08)
Sex (boy)	0.83 (0.67 to 1.03)	0.79 (0.63 to 1.00)	0.91 (0.69 to 1.19)
Father works in dusty environment	1.15 (0.90 to 1.48)	1.64 (1.27 to 2.12)	1.13 (0.82 to 1.55)
Unemployed mother	1.31 (1.01 to 1.68)	1.28 (0.97 to 1.68)	1.11 (0.80 to 1.55)
School in area of increased dust pollution	1.46 (1.14 to 1.87)	1.22 (0.93 to 1.60)	1.28 (0.93 to 1.78)
Damp home	1.56 (1.19 to 2.04)	1.24 (0.92 to 1.62)	1.25 (0.88 to 1.78)
Rented accommodation	1.32 (1.08 to 1.60)	1.08 (0.83 to 1.39)	0.88 (0.64 to 1.21)

School absenteeism for respiratory symptoms is a useful indicator of respiratory morbidity.[3 6 11] Absences from school (for more than six days) due to respiratory symptoms and admissions to hospital for the same reason declined slightly between 1991 and 1993.

RISK FACTORS FOR SYMPTOM PROFILES

Reports of the effects of parental smoking on lung function and respiratory health of children are inconsistent. There are reports of strong associations of childhood respiratory symptoms with passive smoking especially in susceptible children,[12 13] and suggestions that the findings may be dependent on the amount of contact between parent and child,[14] or whether the mother smoked during pregnancy.[15 16] We have been unable to replicate these findings in 1993 despite the large numbers in the study and controlling directly for many social class and environmental factors. Neither was there an association between having been breast fed and later childhood respiratory symptoms, which is in agreement with other recent reports.[17 18] Reported wheeze has been shown to be more likely with the reported presence of dampness in the home,[19] our study supports this. Babies born preterm were more likely to develop the symptom triad during childhood than babies born full term.[20]

There are significant detrimental effects of air pollution on respiratory health.[21-24] In asthmatic children an increase in the severity, but not the prevalence, of respiratory symptoms has been associated with air pollution.[25] Other surveys have reported cough as the main respiratory symptom associated with high levels of air pollution.[6 25-29]

Our earlier report showed that excess cough as a single symptom was associated with particulate air pollution, and the more sophisticated analysis in this paper confirms that observation. However, the single symptom of wheezing and the symptom triad of cough, wheeze, and breathlessness did not correlate with pollution. The symptom triad correlates best with the features of atopy and also with having been born prematurely. The difference in risk profiles between cough alone and the triad of cough, wheeze, and breathlessness are consistent whether the data are analysed by simple univariate comparisons or multiple logistic regression, which suggests that these epidemiological classifications may represent distinct clinical entities. Thus, if a child has cough, wheeze, and breathlessness, then a diagnosis of asthma seems very probable, and conversely the single symptom of excess cough could be a non-specific response to adverse environmental conditions and not represent asthma at all. Such a hypothesis cannot be answered from cross sectional studies alone but there is a further observation that supports it.

Doctor diagnosed asthma was reported in 83 and 90% of children with the symptom triad in 1991 and 1993 against only 10 and 23% of those with excess cough only and hardly at all in asymptomatic children. Treatment prescribing follows a similar pattern. Thus doctors appear to have recognised a similar distinction in clinical practice.

Between 1991 and 1993 there was a significant increase in the prevalence of doctor diagnosed asthma and also in the number of children receiving medication for asthma. Since overall symptom prevalence was unchanged, this suggests a change in medical behaviour. The increase in labelling was most marked in those reporting the single symptom 'excess cough', with more than twice as many of these children being diagnosed as asthmatic and, if allowance is made for the non-asthma medication being unchanged, nearly twice as many received asthma therapy. In 1993, one in eight children that doctors had diagnosed as asthmatic had been diagnosed on the basis of the single symptom of cough. Whether these children really have asthma warranting treatment or whether doctors have become more aware of, and aggressive towards, cough as a marker of asthma remains unknown. Possibly doctors use cough together with auscultation of the chest to reach a diagnosis. If the index of asthma in our survey had been 'doctor diagnosis of asthma' we would be reporting an increase in asthma of nearly 5% over 2 years, which, since overall symptom prevalence was unchanged, would have been misleading.

In conclusion, we hypothesise that the symptom triad of cough, wheeze, and breathlessness occurring in a child may be a better marker of true asthma in epidemiological surveys than relying on either single symptoms or doctor diagnostic patterns. Since asthma prevalence is so dependent on the definition adopted, further studies are needed either to confirm this hypothesis or produce a better version that can be adopted as a standard.

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