Respiratory symptoms and home environment in children: a national survey

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Abstract

***Background*—Respiratory diseases are common in childhood and may lead to chronic disease in adult life; environmental factors probably play an important part in their causation.**

***Methods*—A survey of respiratory symptoms in children aged 12–14 years was conducted throughout Great Britain as part of the International Study of Asthma and Allergies in Childhood (ISAAC). Information was obtained on certain aspects of the home environment in order to assess their importance as risk factors.**

***Results*—The response rate was 79.3%, and 25 393 children in 93 schools participated. In a multiple regression analysis, wheeze was reported more often in non-metropolitan areas and in association with active smoking, passive smoking, the presence of a furry pet, bottled gas, paraffin, and other unusual heating fuels; small regional differences persisted. Current smoking, previous smoking, and passive smoking accounted for 10.4%, 6.8%, and 6.5%, respectively, of wheezing in the past 12 months, and furry pets accounted for 5.0%. Cough and phlegm were associated with active and passive smoking and with the miscellaneous fuels; similar associations were found for rhinitis, but were less consistent for rhinitis occurring in spring and summer. Gas cooking showed little association with respiratory symptoms.**

***Conclusions*—Passive as well as active smoking is an important cause of respiratory symptoms in adolescence. Pets seem to increase the risk of wheeze and rhinitis, and fumes from certain unusual heating fuels may have adverse effects. Home environment and geographical location have independent effects on the prevalence of respiratory symptoms.**

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Respiratory disease is a major cause of ill health and school absence in children. Surveys in different parts of Britain have shown a high prevalence of respiratory symptoms; although these symptoms are mostly caused by quite minor illness, they are liable to persist into adult life and may presage the development of chronic disease.[1 2] In a survey published in 1970 the prevalence of chronic cough among children in different areas ran parallel with the inception rates of incapacity due to bronchitis in men and the death rates from bronchitis and pneumonia in middle aged men and women, suggesting common aetiological factors.[3] It is therefore important to study respiratory symptoms in childhood and to discover what environmental factors are involved, particularly those that are potentially modifiable. Cigarette smoking (active and passive) are obvious factors to be considered; gas cooking[4] and pet ownership[5] have also been implicated, although the evidence is less consistent.

Many surveys have shown associations between respiratory symptoms and the home environment, but they have usually been conducted in localised areas. This survey examines the relationship between a range of respiratory symptoms and housing factors throughout Great Britain. The International Study of Asthma and Allergies in Childhood (ISAAC) is a survey that is being conducted in numerous countries, using a common protocol and a validated questionnaire.[6] When this questionnaire was administered in Britain the opportunity was taken to incorporate some questions about the home environment. The objective was, firstly, to examine the importance of these environmental factors nationally in relation to respiratory symptoms in children and, secondly, to see whether they explained any geographical differences that concurrently emerged from the survey.

Methods

Details have already been published about the ISAAC survey[6] and the way it was conducted in Britain.[7] One mixed comprehensive school was randomly selected from each local education authority in England, Wales, and Scotland. The questionnaire was completed in class, without conferring, by the children in two school years, aged 12–14 years; in addition to the "core" ISAAC questions on asthma and rhinitis, it included other questions about wheeze, cough, phlegm, pet ownership, cooking and heating fuels, house ownership, and cigarette smoking by the child and other residents of the child's house. Questions about symptoms all related to the previous 12 months. One question asked whether wheezing had ever been severe enough to limit speech to one or two words between breaths ("speech limiting wheeze"). Rhinitis was defined as a positive answer to a question about "a problem with sneezing, or a runny or blocked nose, when you DID NOT have a cold or the flu"; results presented here relate to rhinitis "accompanied by itchy watery eyes" and spring/summer rhinitis, defined as rhinitis with itchy watery eyes that occurred only in the months

Table 1 Prevalence of symptoms in boys and girls

Symptom	Prevalence (%)		Adjusted odds ratio (boys = 1.00)	95% Confidence intervals
	Boys	Girls		
Wheeze in past year	32.4	35.3	1.11***	(1.06 to 1.18)
Speech limiting wheeze	8.2	9.5	1.15**	(1.05 to 1.26)
Wheeze without colds	20.8	22.0	1.05	(0.98 to 1.12)
Rhinitis, itchy eyes	15.8	20.8	1.39***	(1.31 to 1.49)
Spring/summer rhinitis	5.2	7.3	1.40***	(1.26 to 1.55)
Cough without colds	28.5	30.3	1.08***	(1.02 to 1.14)
Phlegm with colds	56.9	65.5	1.42***	(1.35 to 1.50)
Phlegm without colds	21.7	20.8	0.91**	(0.86 to 0.97)
> 3 colds in last year	23.1	31.5	1.51***	(1.43 to 1.60)
Dry night cough without colds	43.4	47.4	1.14***	(1.09 to 1.20)

*p<0.05,** p<0.01,*** p<0.001.
Odds ratios are adjusted for age, region, and all the environmental factors in subsequent tables.

from March to September (inclusive). The survey was conducted in the 1995 spring term in all areas. Information about passive smoking related to "anyone you live with" who smokes cigarettes regularly at home. Children were then asked, "Have you ever smoked a cigarette?" "If YES, how often do you smoke nowadays?"

The data were analysed using logistic regression in GLIM.[8] All variables of interest were included in the model. This analysis was restricted to the children who answered all the exposure questions. The population attributable risk was calculated using the formula $p(r—1)/\{p(r—1) + 1\}$, where p is the prevalence of the exposure and r is the relative risk due to the exposure, approximated by the odds ratio.[9]

Results

The survey involved 93 schools containing 32 033 eligible children, of whom 27 507 participated in the survey. The response did not vary significantly between England, Wales and Scotland or between metropolitan and non-metropolitan areas.[7] A total of 25 393 children (79.3% of those originally available) answered all the questions on home environment and are the subject of this report.

Table 1 shows the prevalence of various symptoms in boys and girls with odds ratios adjusted for age and the environmental factors under consideration. All these symptoms were more frequently reported by girls than boys, except phlegm without colds. A rising prevalence with age occurred for wheeze in the last 12 months, wheeze without colds, rhinitis (both types), phlegm with colds, and more than three colds in the last year, while the prevalence declined with age for cough without colds, phlegm without colds, and dry night cough without colds.

Data from this survey showing the prevalence of wheeze and cough in the various regions of Britain have already been published[7]; similar data on the regional prevalence of rhinoconjunctivitis are in preparation. Although the differences were not great, Scotland had the highest prevalence of wheeze and of rhinitis with itchy eyes, and the lowest prevalence of cough without a cold. When adjustments were made for age, sex, and the environmental factors under consideration here, all the symptoms except speech limiting wheeze and spring/summer rhinitis still showed significant

Table 2 Prevalence of symptoms in children grouped by environmental factors

Environmental factor	Total no.	Percentage prevalence of symptoms in children in each environmental group									
		Wheeze	Speech limiting wheeze	Wheeze without colds	Rhinitis, itchy eyes	Spring/summer rhinitis	Cough without colds	Phlegm with colds	Phlegm without colds	>3 colds per year	Dry night cough without colds
Area											
Metropolitan	8955	30.8	8.0	19.4	18.9	6.0	32.3	60.2	23.2	27.2	48.4
Non-metropolitan	16438	35.5	9.3	22.5	18.5	6.7	27.8	61.7	20.2	27.4	43.8
Pets											
None	7204	31.6	8.0	19.6	17.4	5.7	29.6	58.0	20.8	25.6	44.6
Furry pets	16728	34.8	9.2	22.2	19.1	6.7	29.2	62.6	21.4	28.3	45.6
Other pets only	1461	34.5	8.5	21.5	20.1	7.5	31.0	61.1	21.1	24.5	46.3
Cooking fuel											
Electricity only	9277	33.9	8.9	21.6	18.0	6.8	28.2	60.6	20.4	27.2	43.7
Gas	15492	33.8	8.8	21.1	19.0	6.3	30.3	61.4	21.8	27.4	46.5
Other only	624	35.7	9.4	25.3	19.5	6.2	25.0	66.1	18.4	26.8	43.0
Heating fuel											
Electricity only	6795	32.0	8.1	20.0	17.1	5.6	30.0	57.1	20.9	26.5	45.6
Mains gas	12294	33.6	8.6	21.3	19.0	6.9	29.5	61.8	21.1	26.9	45.4
Coal, wood, oil	4109	34.8	9.3	21.7	17.4	6.5	26.3	64.6	20.0	27.3	42.5
Bottled gas, paraffin	1526	38.0	11.6	25.4	23.8	6.5	32.3	64.1	24.8	31.6	49.5
Other	669	42.1	12.4	26.8	25.1	7.0	33.2	63.5	26.9	34.5	51.2
Housing											
Owned	5059	34.4	10.0	22.1	20.6	5.8	36.2	58.3	26.3	30.1	50.6
Council	1013	34.9	9.7	21.5	21.4	7.4	32.7	63.2	23.2	27.9	47.0
Other rented	18338	33.5	8.3	21.2	17.9	6.7	27.2	62.0	19.7	26.3	43.7
Other	983	36.5	11.0	22.5	20.3	5.9	32.8	58.9	22.2	30.5	48.8
Passive smoking											
Nobody	13498	31.8	7.6	20.0	17.2	7.0	25.5	60.6	17.7	25.3	41.2
Mother only	2963	34.5	9.1	21.6	19.6	6.4	32.2	62.1	23.4	28.1	48.8
Father only	3224	34.3	9.6	21.5	17.7	6.7	31.4	59.6	22.8	28.1	46.2
Both	2908	34.9	9.2	22.6	20.1	5.7	32.7	62.4	25.6	28.3	50.1
Other	2800	41.5	13.5	26.9	24.5	4.8	39.3	63.6	29.9	34.2	56.0
Active smoking											
Never	15672	30.2	7.5	18.8	16.7	6.1	27.2	56.8	17.4	24.9	40.6
Ex-smoker	6433	36.6	9.9	23.0	20.5	6.7	29.6	66.3	24.0	28.7	49.9
<Once weekly	699	43.7	12.1	27.7	23.2	9.4	28.8	70.9	25.0	33.9	53.5
Weekly not daily	725	43.3	11.5	27.8	22.4	5.9	34.4	72.8	30.5	35.1	56.3
Daily	1864	48.1	14.2	32.6	26.1	7.9	45.5	72.9	38.6	37.0	62.3
(Missing answers)	—	(1.7)	(1.7)	(1.7)	(1.4)	(1.5)	(1.2)	(1.0)	(1.4)	(0.4)	(0.8)

Table 3 Results of logistic regression for wheeze and rhinitis in past 12 months in relation to environmental factors

	Odds ratios (95% CI) for symptoms, adjusted for age, sex, region, and other factors shown				
Environmental factor	*Wheeze*	*Speech limiting wheeze*	*Wheeze without colds*	*Rhinitis, itchy eyes*	*Spring/summer rhinitis*
Area (Metropolitan = 1.00)	***	*	***		
Non-metropolitan	1.20 (1.12 to 1.28)	1.14 (1.02 to 1.28)	1.15 (1.06 to 1.25)	0.94 (0.86 to 1.02)	1.09 (0.95 to 1.24)
Pets (None = 1.00)	*		*	*	*
Furry pets	1.08 (1.01 to 1.14)	1.09 (0.98 to 1.21)	1.10 (1.02 to 1.18)	1.08 (1.00 to 1.16)	1.16 (1.02 to 1.30)
Other pets only	1.13 (1.00 to 1.28)	1.05 (0.86 to 1.29)	1.11 (0.96 to 1.28)	1.20 (1.04 to 1.39)	1.34 (1.07 to 1.67)
Cooking fuel (Electricity only = 1.00)					
Gas	1.03 (0.97 to 1.10)	1.02 (0.93 to 1.13)	0.99 (0.93 to 1.06)	1.05 (0.98 to 113)	0.90 (0.81 to 1.01)
Other only	0.99 (0.83 to 1.18)	0.95 (0.71 to 1.27)	1.17 (0.96 to 1.42)	1.11 (0.89 to 1.38)	0.87 (0.61 to 1.23)
Heating fuel (Electricity only = 1.00)	***	**	***	***	***
Mains gas	1.10 (1.03 to 1.17)	1.10 (0.99 to 1.23)	1.11 (1.03 to 1.19)	1.18 (1.09 to 1.28)	1.33 (1.17 to 1.51)
Coal, wood, oil	1.07 (0.98 to 1.16)	1.13 (0.98 to 1.32)	1.01 (0.91 to 1.12)	1.05 (0.94 to 1.17)	1.12 (0.94 to 1.33)
Bottled gas, paraffin	1.21 (1.08 to 1.37)	1.38 (1.55 to 1.66)	1.27 (1.11 to 1.45)	1.47 (1.28 to 1.68)	1.21 (0.96 to 1.52)
Other	1.46 (1.23 to 1.72)	1.52 (1.18 to 1.96)	1.36 (1.13 to 1.64)	1.62 (1.33 to 1.96)	1.34 (0.97 to 1.85)
Housing (Owned = 1.00)					
Council	0.96 (0.90 to 1.03)	1.10 (0.98 to 1.23)	0.99 (0.83 to 1.17)	1.08 (0.99 to 1.17)	0.91 (0.80 to 1.05)
Other rented	1.02 (0.89 to 1.16)	1.10 (0.88 to 1.36)	1.02 (0.94 to 1.11)	1.19 (1.02 to 1.39)	1.18 (0.92 to 1.51)
Other	1.08 (0.94 to 1.24)	1.25 (1.01 to 1.54)	1.03 (0.87 to 1.22)	1.12 (0.96 to 1.32)	0.93 (0.71 to 1.23)
Passive smoking (Nobody = 1.00)	***	***	***	***	***
Mother only	1.08 (0.99 to 1.18)	1.13 (0.98 to 1.31)	1.06 (0.96 to 1.17)	1.09 (0.98 to 1.21)	0.90 (0.76 to 1.06)
Father only	1.10 (1.01 to 1.20)	1.23 (1.08 to 1.42)	1.08 (0.98 to 1.19)	0.99 (0.89 to 1.10)	0.96 (0.82 to 1.12)
Both	1.09 (1.00 to 1.19)	1.13 (0.97 to 1.31)	1.11 (1.00 to 1.23)	1.11 (0.99 to 1.23)	0.79 (0.66 to 0.94)
Other	1.30 (1.19 to 1.42)	1.58 (1.38 to 1.81)	1.26 (1.14 to 1.39)	1.34 (1.21 to 1.49)	0.63 (0.52 to 0.77)
Active smoking (Never = 1.00)	***	***	***	***	***
Ex-smoker	1.29 (1.21 to 1.38)	1.29 (1.17 to 1.43)	1.25 (1.17 to 1.35)	1.23 (1.14 to 1.33)	1.10 (0.98 to 1.24)
<Once weekly	1.68 (1.44 to 1.97)	1.58 (1.24 to 2.01)	1.56 (1.31 to 1.85)	1.40 (1.17 to 1.69)	1.52 (1.16 to 1.98)
Weekly not daily	1.65 (1.41 to 1.92)	1.45 (1.14 to 1.84)	1.55 (1.30 to 1.84)	1.33 (1.11 to 1.60)	0.98 (0.71 to 1.35)
Daily	1.95 (1.76 to 2.16)	1.74 (1.49 to 2.03)	1.92 (1.72 to 2.15)	1.55 (1.37 to 1.74)	1.42 (1.17 to 1.72)

*p<0.05, **p<0.01, ***p<0.001 for heterogeneity.

regional heterogeneity, although it was somewhat reduced for some symptoms. For wheeze, the odds ratio for the area with the highest prevalence (Scotland) versus that with the lowest prevalence (West Midlands) was 1.36 unadjusted and 1.22 adjusted; the corresponding odds ratios for rhinitis with itchy eyes (Scotland versus Trent) were 1.32 and 1.30, and for cough without a cold (West Midlands versus Scotland) were 1.45 and 1.47, respectively.

Table 2 shows the prevalence of each symptom in children grouped according to the various environmental factors. The categories in each section are exclusive, and the children are allocated to the lowest applicable category unless indicated otherwise—for example, a house heated by mains gas and coal is classified as being heated by coal. The percentages were calculated after excluding children who did not answer the question about a given symptom (less than 2% for any symptom). The prevalence of symptoms was highest among those who smoked daily; it was also raised among children exposed to passive smoking, particularly where this involved someone other than (or in addition to) a parent. Prevalence tended to be higher in association with heating fuels other than electricity, particularly bottled gas and paraffin, and even more with the category designated as "other" fuels. This group of fuels was used to a much greater extent in the Scottish islands than elsewhere, being reported by 26.9% of children in the Western Isles, 10.3% in Shetland, 7.7% in Orkney, and less than 5% in all other areas.

Table 3 shows the odds ratios for wheeze and rhinitis in relation to various environmental factors. In each case the odds ratio is adjusted for all the other environmental factors and for age, sex, and the region. Each form of wheeze was more common in the non-metropolitan than in the metropolitan areas, and significantly associated with active smoking, past or present. It was also associated with passive smoking from someone other than a parent. Possession of a furry pet was associated with any wheeze in the past year and wheeze without colds; it was unrelated to wheeze that occurred only with colds (data not shown; odds ratio 1.01). There were no obvious relationships with cooking fuel, but the associations with bottled gas, paraffin, and other unusual heating fuels were still evident.

For wheeze in the past 12 months the percentage of cases attributable to various factors was calculated (population attributable risk). Among factors that are potentially modifiable, furry pets accounted for 5.0% of cases (95% CI 0.7 to 8.6), ex-smoking for 6.8% (95% CI 5.1 to 8.7), smoking less than weekly for 1.9% (95% CI 1.2 to 2.6), smoking weekly also for 1.9% (95% CI 1.2 to 2.6), smoking daily for 6.7% (95% CI 5.4 to 8.0), and passive smoking from someone other than (or in addition to) a parent for 3.3% (95% CI 2.1 to 4.6); all current active and passive smoking accounted for 10.4% and 6.5% of cases, respectively.

Rhinitis with itchy eyes was associated with furry and other pets, several heating fuels, active smoking, and passive smoking by someone other than (or in addition to) a parent; the relationship with "other fuels" was particularly strong. When the condition occurred only in spring or summer it was associated with pets, mains gas heating, and active smoking, but inversely related to passive smoking, particularly by someone other than a parent. Table 4 shows a similar analysis for cough and phlegm. Active smoking was strongly associated with all symptoms, and passive smoking was associated with cough and phlegm that occurred in the absence of a cold. The symptoms tended to occur particularly in houses heated by the miscellaneous fuels, bottled gas, and paraffin. Gas cooking was significantly associated only with

Table 4 Results of logistic regression for cough and phlegm in relation to environmental factors

	Odds ratios (95% CI) for symptoms, adjusted for age, sex, region, and other factors shown				
Environmental factor	*Cough without colds*	*Phlegm with colds*	*Phlegm without colds*	*>3 colds per year*	*Dry night cough without colds*
Area (Metropolitan = 1.00)	**		***		***
Non-metropolitan	0.90 (0.83 to 0.96)	0.95 (0.89 to 1.02)	0.84 (0.78 to 0.91)	1.03 (0.95 to 1.10)	0.89 (0.83 to 0.95)
Pets (None = 1.00)		***		**	
Furry pets	0.97 (0.91 to 1.03)	1.13 (1.07 to 1.20)	1.01 (0.94 to 1.08)	1.09 (1.02 to 1.16)	1.01 (0.96 to 1.07)
Other pets only	1.07 (0.94 to 1.21)	1.15 (1.02 to 1.29)	1.02 (0.89 to 1.18)	0.94 (0.82 to 1.07)	1.08 (0.96 to 1.21)
Cooking fuel (Electricity only = 1.00)					
Gas	1.04 (0.98 to 1.11)	1.04 (0.99 to 1.10)	1.07 (1.00 to 1.14)	1.02 (0.96 to 1.09)	1.07 (1.01 to 1.13)
Other only	0.94 (0.78 to 1.15)	1.12 (0.94 to 1.35)	0.92 (0.74 to 1.14)	0.94 (0.78 to 1.14)	1.05 (0.88 to 1.25)
Heating fuel (Electricity only = 1.00)	*	***	**	***	**
Mains gas	0.98 (0.92 to 1.05)	1.26 (1.18 to 1.34)	1.01 (0.94 to 1.09)	1.07 (1.00 to 1.15)	1.01 (0.95 to 1.08)
Coal, wood, oil	0.93 (0.85 to 1.02)	1.35 (1.24 to 1.47)	1.02 (0.92 to 1.13)	1.08 (0.98 to 1.18)	0.97 (0.89 to 1.06)
Bottled gas, paraffin	1.08 (0.95 to 1.22)	1.33 (1.18 to 1.49)	1.17 (1.02 to 1.33)	1.27 (1.12 to 1.43)	1.14 (1.01 to 1.28)
Other	1.23 (1.03 to 1.46)	1.31 (1.11 to 1.56)	1.40 (1.16 to 1.69)	1.50 (1.26 to 1.78)	1.29 (1.10 to 1.52)
Housing (Owned = 1.00)	***	***	***	**	***
Council	1.33 (1.24 to 1.43)	0.82 (0.76 to 0.87)	1.23 (1.14 to 1.33)	1.11 (1.03 to 1.19)	1.14 (1.07 to 1.22)
Other rented	1.18 (1.02 to 1.35)	1.02 (0.89 to 1.16)	1.11 (0.95 to 1.30)	1.03 (0.89 to 1.19)	1.04 (0.91 to 1.18)
Other	1.25 (1.08 to 1.44)	0.87 (0.76 to 0.99)	1.07 (0.91 to 1.26)	1.19 (1.03 to 1.37)	1.18 (1.03 to 1.34)
Passive smoking (Nobody = 1.00)	***		***	***	***
Mother only	1.23 (1.13 to 1.35)	1.04 (0.96 to 1.14)	1.24 (1.12 to 1.37)	1.08 (0.99 to 1.19)	1.23 (1.13 to 1.34)
Father only	1.23 (1.13 to 1.34)	0.95 (0.88 to 1.03)	1.26 (1.14 to 1.38)	1.11 (1.02 to 1.21)	1.14 (1.05 to 1.23)
Both	1.24 (1.14 to 1.36)	1.05 (0.96 to 1.14)	1.38 (1.25 to 1.53)	1.07 (0.97 to 1.17)	1.28 (1.17 to 1.39)
Other	1.52 (1.38 to 1.66)	0.99 (0.90 to 1.08)	1.46 (1.37 to 1.58)	1.33 (1.21 to 1.46)	1.46 (1.32 to 1.58)
Active smoking (Never = 1.00)	***	***	***	***	***
Ex-smoker	1.13 (1.06 to 1.21)	1.46 (1.37 to 1.55)	1.47 (1.37 to 1.58)	1.15 (1.08 to 1.23)	1.44 (1.36 to 1.53)
<Once weekly	1.11 (0.93 to 1.31)	1.71 (1.45 to 2.03)	1.60 (1.34 to 1.92)	1.42 (1.20 to 1.67)	1.68 (1.44 to 1.96)
Weekly not daily	1.38 (1.17 to 1.62)	1.96 (1.66 to 2.33)	2.03 (1.72 to 2.40)	1.48 (1.26 to 1.74)	1.82 (1.56 to 2.11)
Daily	2.07 (1.86 to 2.30)	1.99 (1.78 to 2.22)	2.68 (2.41 to 2.99)	1.53 (1.37 to 1.70)	2.22 (2.00 to 2.46)

*p<0.05, **p<0.01, ***p<0.001 for heterogeneity.

dry night cough. Some of the symptoms were associated with certain types of housing, but the relationships were not consistent.

Discussion

This survey was conducted throughout Britain in a way that ensured comparability of data and representation of all areas, and response rates were high. Although there are inevitable uncertainties about the accuracy of symptom reporting, there is no reason to suspect differential bias in comparing children in various parts of the country or with particular characteristics. This analysis examines the relationships between certain respiratory symptoms and various environmental factors, allowing the effect of each factor to be considered independently by means of logistic regression. As the study is cross sectional, the effects may be underestimated if factors had been modified because of perceived relationships with symptoms. Other aspects of the prevalence of asthma, hay fever, and eczema have been published separately.[7]

The prevalence of some of these symptoms was markedly higher than that reported in other surveys. For example, wheeze during the past year was reported by a third of these children, whereas surveys of 12 year old children in South Wales[10] and Scotland[11] found wheeze during the past year in 15% and 19%, respectively. In these surveys the questionnaires were completed by the parents, whereas the present survey addressed the children directly. In a pilot study it was found that wheeze and cough were reported more frequently by children than by parents answering on their behalf, presumably because the children were aware of symptoms that occurred when they were not in their parents' company. In the present survey symptoms were reported more frequently by girls than by boys, contrary to the findings of the other surveys referred to, possibly because of the different survey methods or because the children were somewhat older. In younger children asthma and wheeze occur more frequently in boys than in girls, but the excess prevalence in boys declines with age,[12] and in young adults the prevalence is higher in women than in men.[13] For reasons that are unknown, the reversal of the sex ratio seems to occur during adolescence. The adjusted odds ratios show that girls are more susceptible than boys with the same degree of exposure to the environmental factors considered here.

The prevalence of wheeze was higher in Scotland than in any other region, contrary to the findings of other surveys that showed a lower prevalence in Scottish children.[14 15] Again, the results are not strictly comparable owing to differences in ages and methods. On the other hand, cough in the absence of a cold was less common in Scotland than elsewhere. The present analysis shows that these differences were not attributable to any of the environmental factors considered here.

It is at first sight surprising that the prevalence of wheeze tended to be higher in the non-metropolitan than in the metropolitan areas. For cough and phlegm the relationship was in the opposite direction. A recent report concluded that there is no convincing evidence that asthma is more common in urban areas than in rural areas in the UK, although there is limited evidence from the UK and elsewhere to suggest a modest relationship between the prevalence of asthma and local traffic density.[16] A study of Swedish conscripts found a higher prevalence of asthma in Stockholm (population 670 000) than in other areas,[17] but a French survey found a lower prevalence of wheezing attacks in Marseille (population 870 000) than in a rural area,[18] while a British national survey found a similar prevalence of wheeze in urban and rural settings.[14] Another

British survey reported that children living in inner cities had more respiratory symptoms than other children,[15] but this does not necessarily conflict with the present findings since most people in a metropolitan area do not live in the inner city. It seems likely that asthma and other respiratory symptoms differ in their epidemiological and aetiological associations.

Furry pets were associated with rhinitis and wheeze, occurring without rather than with colds, presumably because these animals provoke allergic reactions. Another British survey found that wheezy children were more likely than others to own a furry pet[5]; other surveys have failed to show this association,[12 19 20] possibly because parents of allergic children tend not to acquire pets.[21] In so far as allergic families in this study avoided pets, the effects of pets on symptoms will have been underestimated. It is more difficult to explain the associations with phlegm and frequent colds.

Several surveys have shown an increased risk of respiratory symptoms in children whose houses contain gas cookers; a meta-analysis estimated that the odds of respiratory illness were 20% higher in these children.[4] The evidence is not wholly consistent, however[5]; in the present survey (involving even more subjects than were available for the meta-analysis) the use of gas for cooking was associated with slightly raised odds ratios, only one of which was significantly different from unity. Larger associations occurred with heating fuels. Most symptoms were reported less frequently in houses heated only by electricity than in any other type of house, in contrast to a Canadian study that showed an association between asthma and an electric heating system.[22] Perhaps the associations with mains gas heating reflect an effect of open gas fires; the fuel used for central heating can hardly be relevant. Heating by coal, wood and oil showed little effect, except for phlegm with colds, where the association seemed to be attributable to a negative relationship with electricity rather than to a specific effect of these fuels. Other studies have reported positive,[23] negative,[24] and no[25] associations between coal or wood fires and symptoms; in one study heating with coal or wood was apparently protective against hay fever and bronchial hyperresponsiveness.[26] The effects may vary according to the type of appliance and the climate. Bottled gas and paraffin were associated with more symptoms than were any other of the specified fuels, possibly due to a greater production of pollutants; in an Italian survey respiratory symptoms were associated with the use of bottled gas for cooking and stoves fuelled other than by natural gas.[27] But the strongest and most consistent associations with heating fuel in the present data concerned the "other" category. Children whose houses were heated by a fuel other than those specified (whether specified fuels were used or not) were much more likely than other children to report any of the symptoms. It is difficult to interpret this observation. We cannot be sure what these fuels were, since we did not ask the children to identify them, but it is obviously possible that they produce particularly toxic fumes. Presumably they comprise solid fuels other than coal and wood, and the fact that they were used mainly in the Scottish islands suggests that peat may be the principal fuel in this category. A survey in the Scottish Highlands found no relationship between heating fuel and wheeze, cough or hay fever, but it did not distinguish between coal, peat, and wood fires.[28]

The ownership of the house is a marker for socioeconomic status and possibly for the general condition of the house. There was no clear relationship with wheeze; there were several significant associations with cough and phlegm, but they were in opposite directions for different symptoms, so they are not easy to interpret.

All the respiratory symptoms were related in a dose dependent manner to active smoking which, in this age group, was presumably of fairly recent onset. Because a quarter of the children had smoked only at some previous time, the contribution of ex-smoking to the prevalence of wheeze in the population was as great as that of current daily smoking. Thus even temporary and short periods of smoking had substantial effects. Presumably some of the "ex-smokers" had smoked only a very few cigarettes (or just one); the high prevalence of symptoms in ex-smokers may in part reflect a tendency for those who were most obviously affected by smoking to abandon the experiment. Passive smoking was also associated with symptoms, as has been shown in numerous other studies.[29] The strongest associations were with smoking by someone other than (or in addition to) a parent, probably an older sibling, who might share the same bedroom or be otherwise in close proximity to the child. While this association was positive in relation to rhinitis with itchy eyes at any time of year, it was negative in relation to these symptoms occurring only in spring or summer (presumably hay fever or other seasonal allergic rhinitis). These contrary associations were quite strong and are not easy to explain. To some extent an artefact of classification could operate in that children whose symptoms were provoked both by cigarette smoke throughout the year and by seasonal allergens were excluded from the "spring/summer" group, possibly depleting the numbers of children with seasonal rhinitis who were exposed to passive smoking. However, there is some evidence that this is not the whole explanation. A survey in adults suggested that seasonal rhinitis is more likely than perennial rhinitis to have an allergic basis, with different epidemiological associations; seasonal rhinitis was negatively associated with the presence of a smoker in the household but perennial rhinitis showed no association.[30] Perhaps the two conditions involve distinct mechanisms and are affected by passive smoking in different ways. Cigarette smoke is likely to cause nasal and eye irritation at any time of year, but it may also suppress some component of the allergic immune response; the children of smoking mothers have been found to have a lower prevalence of hay fever[28] and skin sensitivity,[31] although the

evidence is not consistent.[32] The different effects of active and passive smoking in this regard call for further investigation.

Thus, this survey underlines the importance of smoking (active and passive) in causing respiratory symptoms in children. There was some effect of pet ownership and unexplained associations with region, non-metropolitan area, and unusual heating fuels which call for further investigation.

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