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Incidence and Remission of Asthma in Schoolchildren: Report From the Obstructive Lung Disease in Northern Sweden Studies

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ABSTRACT. *Objective.* An increasing prevalence of asthma has been reported worldwide as well as in Sweden. In 1996, the prevalence of asthma and type 1 allergy was investigated in a cohort of 3525 children 7 and 8 years old in 3 areas of northern Sweden. The aim of the present study was to estimate the incidence of asthma and to identify risk factors for incident cases over 1 year.

Methods. The study started with a parental questionnaire, the International Study of Asthma and Allergies in Childhood questionnaire with additional questions, a skin prick test, and a validation study. The cohort was followed up after 1 year with the same questions. The response rate to the questionnaire was 97% in 1996, and 3339 children (97%) participated both in 1996 and 1997.

Results. The incidence of physician-diagnosed asthma was 0.9/100/year; of wheezing, 3.8/100/year; and of new frequent or daily users of asthma medicines, 1.1/100/year. There was no difference by sex. The risk factor pattern based on incident cases of asthma was different from that based on prevalent cases. Significant risk factors for incident asthma were a positive skin test (odds ratio [OR]: 9.3; 95% confidence interval [CI]: 3.8–22.7); low birth weight (OR: 7.4; 95% CI: 2.2–24.5); and family history of asthma (OR: 2.6; 95% CI: 1.1–6.3). Having or having had pets at home was associated with a decreased risk for asthma and wheezing based on prevalent cases, although it was associated with an increased risk for incidence of wheezing (OR: 2.9; 95% CI: 1.3–6.2). Remission of asthma, which was reported by 10% of the children with current asthma during 1 year, was associated with a negative skin test.

Conclusion. The incidence of asthma at the age of 8 years was high, but remission was also common. Important risk factors for the development of asthma at this age were type 1 allergy, low birth weight, and family history of asthma. Furthermore, the results suggest that in a region where sensitivity to domestic animals is a strong risk factor for asthma, the presence of pets in the home may have different effects in early childhood compared with later in childhood. *Pediatrics* 2001;107(3). URL: <http://www.pediatrics.org/cgi/content/full/107/3/e37>; asthma, incidence, remission, risk factors, children.

ABBREVIATIONS. ISAAC, International Study of Asthma and Allergies in Childhood; OR, odds ratio; CI, confidence interval.

Numerous cross-sectional studies on the prevalence of asthma in both children and adults have been reported in the last 2 decades. Different methods and different diagnostic criteria make the interpretation of results difficult; however, the studies give a consistent picture of an increasing prevalence of asthma mainly in children, teenagers, and young adults. The increase is worldwide.^{1–4} Several studies have shown similar patterns of risk factors for asthma in high- and low-prevalence countries or areas. However, there is no general agreement about the causes of the increase.

Two important risk factors for asthma have been consistently demonstrated in cross-sectional studies: family history of asthma^{4–6} and allergic sensitization or atopy.^{6–8} Predominantly indoor allergens are of importance,^{8–10} but the dominant allergens vary in different parts of the world, depending both on climate and indoor environments. Other risk factors may also vary, depending on environmental, socioeconomic, or cultural factors. Such risk factors include parental, particularly maternal, smoking^{10–14} and dampness at home.^{6,10,11} Low birth weight^{14,15} and breastfeeding of infants for less than a few months¹⁶ have also been identified as risk factors for asthma. The risk factors for incident cases in longitudinal studies have been poorly studied.

Data on incidence and remission are still uncommon, because longitudinal follow-up studies of large cohorts are required to obtain such data. In addition, it is an advantage if the follow-ups can be performed within short intervals, because both new onset of disease and symptoms,¹⁷ as well as remission of asthma,¹⁸ are common in young children. A study in progress in northern Sweden showed that in 1996, 7% of schoolchildren 7 to 8 years old were using asthma medicines and 4% inhaled corticosteroids.⁶ The aims of the present study were to measure the incidence and remission of asthma and wheezing over a 1-year period and to examine risk factors related to both incidence and remission of asthma in this population of schoolchildren.

METHODS

All children enrolled in the first and second grades in 1996 in the towns or municipalities of Kiruna, Luleå, and Piteå in northern Sweden were invited to take part in a longitudinal study of

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asthma and other allergic diseases. As a starting point, an expanded International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire¹⁹ was used to estimate the prevalence of asthma, rhinitis, and eczema, as well as risk factors for these conditions.^{6,13} The children in Kiruna and Luleå were invited to undergo skin tests.⁶ This first survey was performed from February through April 1996. The second survey was performed during the same period 1 year later. The questionnaire with a covering letter was distributed to the parents of the children by the teachers. The data of incidence and remission were based on the results from the 2 surveys on the same sample of schoolchildren.

The study was approved by the ethical committee at the University and the University Hospital of Northern Sweden in Umeå.

Study Population

Of the 3525 schoolchildren enrolled in class 1 and 2, mainly 7 to 8 years old, 3431 (97%) participated in the first survey. One year later, 3542 children were enrolled in the actual grade classes at the schools in the 3 municipalities, and 3453 (97.5%) participated at the follow-up survey in 1997. Of the participants in the 1996 study, 3339 (97%) participated in the follow-up survey (Table 1).

Methods

In addition to the core questions from the ISAAC questionnaire¹⁹ about asthma and wheezing, rhinitis, and eczema, additional questions were added as at the first survey.⁶ The ISAAC questionnaire included questions about ever asthma, ever wheeze, wheezing during last 12 months, frequency and severity of wheeze, and the additional questions included physician-diagnosed diseases, use of medicines, family history of asthma or allergic diseases, and exposure to possible risk factors, such as past or present pets at home, parental smoking, house dampness, and other factors in childhood. Respiratory infection was defined as a history of whooping cough, croup, pneumonia, or severe respiratory infection including respiratory syncytial virus.

Asthma was surveyed in the questionnaire by 2 separate questions: ever asthma—"Has your child ever had asthma?"¹⁹; and physician-diagnosed asthma—"Has your child been diagnosed by a physician as having asthma?"^{6,13}

The term current asthma was defined as follows: physician-diagnosed asthma and either symptoms related to asthma or use of asthma medicines during the last 12 months.^{6,13}

The frequency of use of asthma medicines was surveyed as follows: "How often has the child used asthma medicines during the last 12 months?" The alternatives were: never, sometimes, frequently/periodically, or daily.^{6,13}

Wheeze was surveyed as follows: ever wheeze—"Has your child had wheezing or whistling in the chest at any time in the past?"¹⁹; and wheezing last 12 months—"Has your child had wheezing or whistling in the chest in the last 12 months?"¹⁹

Type 1 allergy was defined as at least one positive skin test. The tests were performed with 10 standardized allergens from ALK (Hørsholm, Denmark), and a lancet, as single test on one arm. The following allergens were used: birch, timothy, mugwort, cat, dog, horse, *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, *Cladosporium*, and *Alternaria*. The test was considered as positive if the weal was 3 mm or more.⁶

Analyses

Calculation of the incidence of asthma, wheezing, and use of asthma medicines was based on the 2 surveys performed in 1996

and 1997. The incidence has been expressed as the proportion of children without the studied condition in 1996 who developed the condition during the 1-year period under study. The incidence of asthma was estimated for 3 categories of asthma, the incidence of ever asthma, physician-diagnosed asthma, and current asthma.

The question about physician-diagnosed asthma in the 1996 survey had been validated by pediatricians.¹³ One third of all children with physician-diagnosed asthma were invited. In addition, all children using asthma medicines without having physician-diagnosed asthma as well as symptomatic children were examined.¹³ The children who were judged as having asthma or having had asthma at these examinations, and the children with questionnaire based physician-diagnosed asthma or ever asthma according to the 1996 questionnaire were excluded from the population under risk, when the incidence of asthma was calculated.

As a comparison, the incidence rates of the different asthma categories were compared with the incidence of frequently or daily users of asthma medicines. The incidence of all users of asthma medicines was also estimated. These calculations were made from the children without any use of asthma medicines in 1996.

The incidence of wheezing last 12 months was based on the question about the condition in 1997 among the children who did not answer yes to the questions about ever wheeze or wheezing last 12 months in the 1996 survey.

All data about risk factors were collected in the 1996 survey. Odds ratios (ORs) and 95% confidence interval (CI) for independent variables as risk factors for asthma and wheezing, respectively, were calculated by using multiple logistic regression analysis. The independent variables included gender; family history of asthma; past or present mother's smoking; past or present dampness at home; breastfeeding ≤ 3 months; birth weight <2500 g; respiratory infections; past or present having cat, dog, or other pets at home; area of domicile; and, in two thirds of the sample, results from skin test. Other examined possible risk factors were: area of domicile, urban versus rural living, number of siblings, birth order, smoking habits of the father, type of dwelling, and stay at day care center. As dependent variables the 3 asthma categories were selected, and they were ever asthma, physician-diagnosed asthma, and current asthma, and also wheezing last 12 months. Of the asthma categories, the results for "ever asthma" have been presented, because the incident cases of the 2 others were fewer, which affected the power and the significance of the analysis.

RESULTS

Prevalence

The prevalence of ever asthma was 7.7% in 1997. The corresponding figures for physician-diagnosed asthma were 6.6%, and for current asthma 5.7%, respectively. These prevalence rates were somewhat higher in 1997 compared with 1996, whereas the prevalence of wheezing last 12 months was 12.0% in 1996 and 10.7% in 1997 (Table 2).

The prevalence of children with any use of asthma medicines had increased to levels close to the prevalence of wheezing, whereas the proportion of children who reported frequent or daily use of asthma

TABLE 1. Study Population: Number of Children Who Were Invited and Who Participated in 1996 and 1997, Respectively, and Number of Children Who Participated in Both 1996 and 1997 by Area and Sex

Cohort	Study Year		Kiruna	Luleå	Piteå	Boys	Girls	All
Invited	1996	<i>n</i>	680	1774	1071	1797	1728	3525
		<i>n</i>	671	1757	1003	1750	1681	3431
		(%)	(99%)	(99%)	(94%)	(97%)	(97%)	(97%)
Invited	1997	<i>n</i>	674	1795	1073	1805	1737	3542
		<i>n</i>	658	1743	1052	1759	1694	3453
		(%)	(98%)	(97%)	(98%)	(97%)	(98%)	(97.5%)
Participated	1996 and 1997	<i>n</i>	648	1707	984	1699	1640	3339
Proportion of participants in	1996	(%)	(97%)	(97%)	(98%)	(97%)	(98%)	(97%)

TABLE 2. Prevalence (%) of Ever Asthma, Physician Diagnosed Asthma, Current Asthma, Wheezing Last 12 Months, and Different Use of Asthma Medicines Among Boys and Girls in 1996 and 1997, Respectively*

Condition	Year	Boys	Girls	All	Difference by	
					Sex	Year†
Ever asthma	1996	7.8	4.9	6.4	<.001	
	1997	9.4	6.0	7.7	<.001	.031
Physician-diagnosed asthma	1996	7.1	4.3	5.7	<.001	
	1997	7.9	5.0	6.5	.001	.228
Current asthma	1996	6.5	4.2	5.3	.002	
	1997	6.9	4.5	5.7	.003	.493
Wheezing last 12 mo	1996	12.9	10.4	11.7	.016	
	1997	12.0	9.3	10.7	.009	.161
Use of asthma medicines last 12 mo						
Any medicines	1996	8.1	6.0	7.1	.019	
	1997	11.1	8.4	9.8	.005	<.001
Frequent or daily use	1996	3.9	2.9	3.4	.079	
	1997	4.0	3.7	3.9	.530	.427
Use of inhaled corticosteroids	1996	5.0	3.6	4.3	.049	
	1997	4.7	3.2	4.0	.080	.460

* Difference (*P* value) by sex and study year.

† Difference by year refers to the whole group.

medicines, or use of inhaled corticosteroids, was similar in 1996 and 1997 (Table 2). The prevalence of each of the different measures of asthma, as well as of wheezing and any use of asthma medicines, were all significantly higher among boys (Table 2), while no significant differences between the 3 areas were found (data not shown).

Incidence

The incidence of both physician-diagnosed asthma and current asthma was 0.9/100/year and was similar among boys and girls, whereas the incidence based on the question about ever asthma was higher (1.4/100/year; Table 3). When only the children who had reported a diagnosis of asthma by a physician in 1996 were excluded from the population at risk, the incidence of physician-diagnosed asthma was 1.6/100/year.

The incidence of children who reported that they were using asthma medicines frequently or daily and had not used any asthma medicines in 1996 was 1.1/100/year, whereas the incidence of either frequent or daily use of asthma medicines or physician-diagnosed asthma was 1.6/100/year. The incidence of wheezing was slightly more common among boys (4.4/100/year vs 3.2/100/year among girls; *P* =

.009). No significant differences were found between the 3 areas.

The incident cases of physician-diagnosed asthma were 29 (16 boys). Of these, 23 reported wheezing, 26 use of asthma medicines, 14 use of inhaled corticosteroids, and 11 frequent or daily use of asthma medicines. Ten of the 29 children had reported "wheezing ever" in 1996, and 5 of these 10 reported that wheezing had been present during the year before the year under study; however, it had occurred <4 times.

Remission

Of the children who in 1996 had current asthma, defined as physician-diagnosed asthma and report of either symptoms or use of asthma medicines, 176 (97%) participated at the follow-up survey. Among them 17 children, 7 boys and 10 girls, reported in 1997 that they had not had any wheeze or attacks of shortness of breath or that they had not used asthma medicines during the last 12 months. Thus, the 1-year remission rate was 9.6% of the children who 1 year before the study had had active asthma, which corresponds to 0.5% of all children in the cohort, or ~50% of the 1-year incidence of current asthma.

Of the 17 children, 8 had been skin tested in 1996,

TABLE 3. One-Year Incidence (1996–1997) of Ever Asthma, Physician-Diagnosed Asthma, Current Asthma, Wheezing, and Frequent or Daily Use of Asthma Medicines, Among Girls and Boys*

Condition		Boys	Girls	All	Difference by Sex
Ever asthma	% (n)	1.6 (24)	1.3 (20)	1.4 (44)	.55
Physician-diagnosed asthma	% (n)	1.0 (16)	0.9 (13)	0.9 (29)	.58
Current asthma	% (n)	0.9 (14)	0.9 (13)	0.9 (27)	.86
Wheezing last 12 mo	% (n)	4.4 (56)	3.2 (42)	3.8 (98)	.09
Frequent use of asthma medicines†	% (n)	1.0 (16)	1.2 (19)	1.1 (35)	.61
Physician-diagnosed asthma or frequent use of asthma medicines	% (n)	1.7 (26)	1.5 (23)	1.6 (49)	.10

* Percentage and total numbers (*n*) of incident cases. Difference (*P* value) by sex.

† Participants with any use of asthma medicines before the year under study have been excluded when analysing the incidence.

and all 8 had had a negative skin test. Of the skin-tested children with current asthma in 1996, who not were in remission 1 year later, 57% had had a positive skin test. No significant differences were found in other possible determinants of remission including nonsmoking parents, low birth weight, respiratory infections in childhood, or length of breastfeeding.

Effects of Smoking Habits of the Mother

Maternal smoking was significantly associated with a birth weight of <2500 g of the child, 6.6% versus 3.1% ($P < .001$), and breastfeeding 3 months or less, 39.3% versus 18.9% ($P < .001$). In addition, a slightly higher prevalence of respiratory infections, however, not significantly (62.0% vs 58.8%; $P = .09$), was found among the children whose mothers were smokers.

Multivariate Relationships Based on Prevalent Cases of Asthma

The risk factor patterns for ever asthma, physician-diagnosed asthma, and current asthma were all similar. Significant risk factors for ever asthma in the whole cohort were family history of asthma (OR: 3.2; 95% CI: 2.4–4.3), birth weight <2500 g (OR: 2.9; 95% CI: 1.8–4.8), any respiratory infections in early childhood (OR: 2.2; 1.6–3.0), male sex (OR: 1.8; 95% CI: 1.4–2.4), past or present dampness at home (OR: 1.6; 1.1–2.2), and past or present mother's smoking (OR: 1.4; 95% CI: 1.1–1.9; Table 4).

Breastfeeding ≤ 3 months was not significantly associated with asthma; however, it became significant when respiratory infections were excluded from the model. Having dog, cat, or other pets at home, either currently or in the past, was associated with a significantly lower risk (OR: .7; 95% CI: .5–.9). The risks for wheezing last 12 months were generally lower than for the different asthma categories; however, the risk factor pattern was similar. In addition, breastfeeding ≤ 3 months was a significant risk factor for wheezing with an OR of 1.4 (95% CI: 1.1–1.8).

When the analyses were performed on the two thirds of the cohort that had been skin tested in 1996 and type 1 allergy was included in the logistic model, positive skin test became the strongest risk factor for

ever asthma, with an OR of 5.4 (95% CI: 3.7–7.7). The other risk factors remained similar compared with the analyses not including type 1 allergy. That was also true for wheezing last 12 months; however, having pets at home was no longer associated with a decreased risk for this category (Table 5).

Multivariate Relationships Based on Incident Cases of Asthma

The risk factor pattern for incident cases of asthma in the whole cohort was different from that for prevalent cases of asthma. The category that yielded the strongest power and the most significant model, ie, ever asthma, was chosen for these analyses. Low birth weight was the dominating risk factor with an OR of 6.7 (95% CI: 2.9–15.2). Of the other potential risk factors used in the model, only family history of asthma (OR: 2.2; 95% CI: 1.1–4.3) reached significance.

For incident cases of wheezing, family history of asthma yielded the highest risk (OR 2.4; 95% CI: 1.6–3.8). In contrast to the analyses based on prevalent cases, having cat, dog, or other pets at home, past or present, now appeared as a significant risk factor for wheezing with an OR of 1.8 (95% CI: 1.0–3.1). Other significant risk factors were male sex (OR: 1.7; 95% CI: 1.1–2.6), and past or present dampness at home (OR: 1.7; 95% CI: 1.0–2.8; Table 4).

When these analyses were performed among those who had been skin tested in 1996, type 1 allergy became the dominating risk factor for ever asthma (OR: 9.3; 95% CI: 3.8–22.7). Low birth weight and family history of asthma remained significant risk factors. For incident wheezing, a positive skin test also yielded the highest risk (OR: 3.3; 95% CI: 1.9–5.9), followed by past or present having cat, dog, or other pets at home (OR: 2.9; 95% CI: 1.33–6.21), and family history of asthma (OR: 2.8; 95% CI: 1.6–4.8; Table 5).

The 2 main risk factors, type 1 allergy and low birth weight, were not related to each other. No significant association was found between type 1 allergy and respiratory infections in childhood.

Other possible risk factors examined: area of domicile, urban versus rural living, number of siblings, birth order, smoking habits of the father, or stay at

TABLE 4. Risk Factors for Asthma (Ever Asthma) and Wheezing Last 12 Months Based on Prevalent Cases in 1997, and on Incident Cases 1996–1997, Respectively*

Independent Variables	%	Dependent Variables			
		Prevalent Cases of		Incident Cases of	
		Asthma ($n = 229$) OR 95% CI	Wheeze ($n = 327$) OR 95% CI	Asthma ($n = 40$) OR 95% CI	Wheeze ($n = 89$) OR 95% CI
Male sex	51.0	1.80 (1.35–2.40)	1.40 (1.10–1.78)	1.46 (0.77–2.78)	1.66 (1.07–2.57)
Family history of asthma	24.3	3.21 (2.42–4.26)	2.38 (1.87–3.04)	2.21 (1.14–4.25)	2.44 (1.56–3.82)
Birth weight <2500 g	4.2	2.94 (1.80–4.81)	2.24 (1.43–3.52)	6.65 (2.92–15.16)	1.43 (0.51–4.06)
Breastfeeding ≤ 3 mo	25.7	1.22 (0.89–1.67)	1.37 (1.05–1.79)	0.86 (0.40–1.85)	1.53 (0.96–2.45)
Respiratory infections	59.9	2.17 (1.58–3.00)	1.97 (1.51–2.56)	1.59 (0.80–3.16)	1.43 (0.92–2.22)
Mother smoker	31.5	1.43 (1.06–1.92)	1.29 (1.00–1.66)	1.16 (0.58–2.31)	1.21 (0.77–1.91)
House dampness	17.5	1.58 (1.14–2.19)	1.58 (1.20–2.09)	0.98 (0.43–2.25)	1.70 (1.03–2.81)
Pets at home	71.6	0.67 (0.50–0.89)	0.80 (0.62–1.04)	0.81 (0.41–1.59)	1.78 (1.02–3.10)

* Prevalence (%) of each independent risk factor in the whole cohort. Analysis were performed in the whole study population. ORs were calculated by multiple logistic regression analysis.

TABLE 5. Risk Factors for Asthma (Ever Asthma) and Wheezing Last 12 Months Based on Prevalent Cases in 1997 and on Incident Cases 1996–1997, Respectively*

Independent Variables	%	Dependent Variables			
		Prevalent Cases of		Incident Cases of:	
		Asthma (<i>n</i> = 149) OR 95% CI	Wheeze (<i>n</i> = 227) OR 95% CI	Asthma (<i>n</i> = 23) OR 95% CI	Wheeze (<i>n</i> = 59) OR 95% CI
Male sex	50.0	2.01 (1.38–2.93)	1.28 (0.95–1.72)	1.92 (0.78–4.73)	1.31 (0.76–2.25)
Family history of asthma	25.1	2.93 (2.03–4.21)	2.40 (1.77–3.24)	2.63 (1.11–6.26)	2.77 (1.61–4.76)
Birth weight <2500 g	3.7	3.20 (1.65–6.22)	2.27 (1.25–4.12)	7.37 (2.22–24.46)	1.80 (0.53–6.14)
Breastfeeding ≤3 mo	22.5	1.17 (0.77–1.78)	1.60 (1.14–2.23)	1.40 (0.51–3.81)	1.73 (0.96–3.14)
Respiratory infections	58.3	2.30 (1.53–3.45)	2.17 (1.56–3.01)	1.86 (0.74–4.66)	1.58 (0.90–2.75)
Mother smoker	31.8	1.83 (1.25–2.69)	1.48 (1.08–2.03)	1.14 (0.45–2.91)	1.24 (0.70–2.20)
House dampness	20.8	1.90 (1.28–2.82)	1.64 (1.18–2.27)	0.85 (0.28–2.58)	1.66 (0.92–3.02)
Pets at home	69.4	0.74 (0.51–1.09)	1.04 (0.75–1.44)	0.64 (0.27–1.52)	2.88 (1.33–6.21)
Type 1 allergy	20.6	5.35 (3.69–7.74)	4.51 (3.31–6.14)	9.33 (3.83–22.71)	3.34 (1.90–5.87)

* Analysis were performed in the 2149 children who were skin tested. Prevalence (%) of each independent risk factor in this cohort. ORs were calculated by multiple logistic regression analysis.

day care center were not significantly associated with either prevalent or incident asthma.

DISCUSSION

In this study of 3339 schoolchildren, we found a high incidence of asthma, but also a high rate of remission over 1 year. Furthermore, the study demonstrated differences in the risk factor pattern of asthma, when the analyses were based on incident cases compared with prevalent cases of asthma. The participation rate was high, 97%, strongly supporting the validity of the results. The prevalence of asthma was slightly higher in 1997 compared with 1996, although no increase of the prevalence of wheezing during the last 12 months was found. The use of any asthma medicines during the last 12 months was significantly higher in 1997, but not the use of inhaled corticosteroids. In keeping with previous results, the prevalence rates of all variables related to asthma were higher among boys.^{17,20,21}

The incidence of physician-diagnosed asthma was 0.9/100/year. This was higher than Broder et al²⁰ found during the 1960s, but similar to more recent results from Dodge and Burrows.²¹ Somewhat higher incidence was found in England during the 1960s in similar ages (1.1/100/year); however, they included asthma or wheezing in the definition.¹⁷ A register study by Yunginger et al²² reported an incidence rate less than half that found in our study in similar ages. In Swedish teenagers an incidence rate of more than 1/100/year has been reported.^{23,24}

The incidence rate in our study may be underestimated. Before correction for undiagnosed asthma in the first survey, the incidence was 1.6/100/year, whereas after correction for the results from the validation study¹³ it was 0.9/100/year, which was similar to the incidence of new frequent users of asthma medicines as well as of current asthma. However, some children with new onset of mild and undiagnosed asthma would not have been included in the results, and the incidence of wheezing was high. In contrast, some of the incident asthmatic children had reported occasional wheezing in the past. This result illustrates the difficulty of deciding exactly when the disease started. The onset of asthma is usually not

from one day to the next, and it may start with mild symptoms.

The incidence of wheezing was surprisingly high (3.8/100/year). It is possible that repeating the survey may have resulted in an increased observance of mild symptoms. However, a study by Sears and colleagues²⁵ in New Zealand concluded that repeated surveys in a population did not influence the prevalence of asthma.

The remission of asthma was also high. Ten percent of the children with current asthma in 1996 reported no shortness of breath, no wheezing, and no use of asthma medicines in the follow-up 1 year later. The high remission rate is in accordance with other studies, which have shown that ~50% of childhood asthma may remit.^{26,27} Among teenagers a remission rate of 5.7% per year has been reported,²⁴ whereas in a follow-up study from 8 to 25 years of age, 24% became free from respiratory symptoms.²⁷ In another follow-up study from 15 to 23 years of age, 16% of the participants were free from asthma medicines and wheezing.²⁸

Our analysis of prevalent asthma in this cohort in 1996 demonstrated important differences in the pattern of risk factors for allergic and nonallergic asthma.¹³ The present results show that the risk factors that were specific for nonallergic asthma, ie, ≤3 months breastfeeding, maternal smoking, and home dampness, were not significantly related to incident asthma. By contrast, as found by others,^{17,24,29} atopy in 1996 was strongly associated with incident asthma over the next year (OR: 9.3).

The relevance of pets at home continues to provide surprising results. Past or present pets at home were a negative risk factor for asthma in 1996 and again in 1997 in keeping with other results.^{30,31} This finding could be the result of avoidance of pets by families with atopic disease,³² but because the results were adjusted for a family history of asthma, induction of tolerance in early childhood cannot be excluded. A recent study has also shown a lack of relation between levels of exposure to cat allergen and asthma.³³ However, in the evaluation of incident disease, pets at home became a significant positive risk factor

for wheezing, a symptom that is common before the diagnosis of asthma.

Environmental tobacco smoke^{10–14,18,30} and dampness^{5,10,11,30} have been reported to be risk factors for asthma, and were significant in relation to prevalent asthma in our cohort. These environmental risk factors did not appear as significant risk factors for development of asthma after ages 7 or 8 years. However, these results could be explained by the limited number of new cases of asthma, because the effect of dampness on incident wheezing yielded similar and significant ORs to those for prevalent cases. Maternal smoking, in contrast, resulted in lower risks compared with prevalent cases. This result may also relate to exposure, because children of school ages spend less time at home and with their mothers. In this part of northern Sweden, the effect of dampness is not a sign of mites or molds because no mites had been found in the homes³⁴ and only very few children were sensitized to mites or molds.^{6,34}

Low birth weight was an important risk factor for asthma in the analyses based on both prevalent and incident cases. Previous studies have shown that low birth weight can be a risk factor for asthma in children and adults.^{14,15} We assume that the low birth weight is related to small airways, which in turn increases the susceptibility to asthma. An important finding was that birth weight was unrelated to atopy. Low birth weight, short time of breastfeeding, and respiratory infections in childhood were each related to maternal smoking. However, because each of these was independently related to asthma, the total effect of maternal smoking may be underestimated.

The effects of breastfeeding on asthma are controversial, with different studies reporting opposite effects.^{5,14,16,35} In our study, short duration of breastfeeding was a significant risk factor in 1996,¹³ but not in 1997, and short breastfeeding was not significantly associated with incident asthma. Similarly, a history of respiratory infections was not related to incident asthma. Whether the associations between respiratory infections and prevalent asthma reflect cause or effect is not clear from our results. Children with asthma may be more susceptible to viral and bacterial infections. The relevance of infections to the development of asthma remains unclear. An increased risk for asthma as a result of respiratory infections has been reported,^{5,36} in contrast, a protective effect for allergy has also been reported.³⁶

The number of children reporting remission of asthma was limited, and it is not surprising that factors related to remission could not be evaluated well. Nonetheless, a negative skin test in 1996 was clearly associated with remission in the next year. Of the children who had been skin tested and who were in remission, all had negative skin tests.

Our results support the view that asthma is a heterogeneous condition^{13,18,36} and indicate that the association between asthma and type 1 allergy becomes stronger after age 7 years. Many children who developed asthma at age 8 years were skin test-positive before they developed the disease.

CONCLUSION

The incidence of asthma was high (1/100/year), but remission was also common. Important risk factors for the development of asthma at 8 years of age were type 1 allergy, low birth weight, and family history of asthma. Furthermore, the results suggest that in a region where sensitivity to domestic animals is a strong risk factor for asthma, the presence of pets in the home may have different effects in early childhood compared with later childhood.

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