

available at [www.sciencedirect.com](http://www.sciencedirect.com)journal homepage: [www.elsevier.com/locate/rmed](http://www.elsevier.com/locate/rmed)

# Allergic rhinoconjunctivitis doubles the risk for incident asthma – Results from a population study in Helsinki, Finland

P. Pallasaho<sup>a,b,\*</sup>, M. Juusela<sup>a,c</sup>, A. Lindqvist<sup>d,e</sup>, A. Sovijärvi<sup>c</sup>,  
B. Lundbäck<sup>f,g</sup>, E. Rönmark<sup>g,h</sup>

<sup>a</sup> Division of Allergology, Skin and Allergy Hospital, Department of Medicine, Helsinki University Central Hospital, Helsinki, Finland

<sup>b</sup> Finnish Institute of Occupational Health, Helsinki, Finland

<sup>c</sup> Division of Clinical Physiology and Nuclear Medicine, Laboratory Department, Helsinki University Central Hospital, Helsinki, Finland

<sup>d</sup> Research Unit of Pulmonary Diseases, Department of Medicine, Helsinki University Central Hospital, Helsinki, Finland

<sup>e</sup> Clinical Research Institute HUCH Ltd., Helsinki, Finland

<sup>f</sup> Department of Internal Medicine, Krefting Research Center, Sahlgrenska Academy, University of Gothenburg, Sweden

<sup>g</sup> Obstructive Lung disease in Northern Sweden (OLIN) Studies, Department of Medicine, Sunderby Central Hospital of Norrbotten, Sweden

<sup>h</sup> Department of Clinical Medicine and Public Health, Environmental and Occupational Medicine, University of Umeå, Sweden

Received 14 November 2010; accepted 22 April 2011

Available online 20 May 2011

## KEYWORDS

Allergic rhinitis;  
Asthma;  
Epidemiology;  
Incidence;  
Risk factors

## Summary

**Objective:** To examine the incidence of allergic rhinoconjunctivitis and asthma, and to assess allergic rhinoconjunctivitis as a risk factor for incident asthma, we performed a 11-year follow-up postal survey.

**Methods:** The original study population was a random population sample of 8000 inhabitants of Helsinki aged 20–69 years in 1996. Participants in the first postal questionnaire survey, 6062 subjects, were invited to this follow-up study, and provided 4302 (78%) answers out of 5484 traced subjects in 2007.

**Results:** Cumulative incidence of asthma from 1996 to 2007 was 4.0% corresponding to an annual incidence rate of 3.7/1000/year. After exclusion of those with asthma medication or physician-diagnosed chronic bronchitis or COPD at baseline in 1996, the cumulative incidence decreased to 3.5% (incidence rate 3.2/1000/year), and further to 2.7% (2.5/1000/year) when also those reporting recurrent wheeze or shortness of breath during the last year in 1996 were

\* Corresponding author. Finnish Institute of Occupational Health, Topeliuksenkatu 41 a A, 00250 Helsinki, Finland. Tel.: +358 50 5338809.  
E-mail address: [paula.pallasaho@finnet.fi](mailto:paula.pallasaho@finnet.fi) (P. Pallasaho).

omitted from the population at risk. Remission of asthma occurred in 43 subjects and was 16.9% over 11 years. Cumulative 11-year incidence of allergic rhinoconjunctivitis was 16.9% corresponding to 16.8/1000/year, and cumulative remission was 18.1%. Incidence of allergic rhinoconjunctivitis was significantly lower among those who had lived in the countryside or on a farm during the first 5 years of life, but this was not true for asthma. In multivariate analysis, farm living during the first 5 years of life was protective for the development of allergic rhinoconjunctivitis, OR 0.75 (95%CI 0.57–0.99). Allergic rhinoconjunctivitis was a significant independent risk factor for incident asthma, OR 2.15 (95%CI 1.54–3.02). In the cohort, the prevalence of rhinoconjunctivitis increased from 38.0% in 1996 to 40.9% in 2007, physician-diagnosed asthma from 6.8% to 9.4%, while current smoking decreased from 31.3% to 23.3%. **Conclusion:** Incidence of allergic rhinoconjunctivitis was higher than in earlier studies, while asthma incidence remained on similar level, both being significantly higher in women. Allergic rhinoconjunctivitis doubled the risk for incident asthma.

© 2011 Elsevier Ltd. All rights reserved.

## Introduction

To respond to the increasing burden and costs due to asthma in Finland, a national Asthma Programme was conducted from 1994 to 2004.<sup>1</sup> During this period, a further increase occurred in prevalence of asthma and in use of asthma medicines, but also a decrease in hospital days, and disability pensions, as well as in costs per patient.<sup>1</sup> Asthma incidence increased in the 1990s,<sup>2,3</sup> and the latest measures of incidence of asthma among adults range from 2.1 to 2.5/1000 per year in Finland.<sup>4,5</sup> A national Allergy Programme launched in 2008 is aiming to reduce the burden of allergic diseases including asthma and allergic rhinoconjunctivitis by 2018.<sup>6</sup>

Studies of incidence of asthma are still scarce. Studies by the Swedish Obstructive Lung Diseases in northern Sweden (OLIN) reported a cumulative 10-year asthma incidence of 3.2% among men and 4.5% among women from 1986 to 1996.<sup>7</sup> After excluding those with symptoms common in asthma and chronic bronchitis from the population at risk, the annual incidence for men was 1.7/1000 and for women 2.9/1000.<sup>7</sup> The Swedish part of the European Community Respiratory Health Survey (ECHRS) from 1990 to 2000 and the Stockholm part of the FinEsS (Finland-Estonia-Sweden) studies between 1996 and 2007 reported similar results with a similar gender difference.<sup>8,9</sup> The average incidence of asthma was 2.2/1000/year in a pooled analysis of the ECRHS from northern Europe.<sup>9</sup> Data from the ECRHS recently showed both non-allergic and allergic rhinitis to be significant risk factors for incident asthma, which was not true for atopy only.<sup>10</sup> Remission of asthma during a 10-year follow-up was 20% in the ECRHS from northern Europe,<sup>11</sup> and 15% in the FinEsS study from Stockholm.<sup>8</sup> In the OLIN studies, 5% of adult-onset asthma was in remission after a mean follow-up of 6 years.<sup>12</sup> Incidence and remission of allergic rhinoconjunctivitis are less studied than of asthma, although they often co-exist and affect each others' course.<sup>13</sup>

We performed an 11-year follow-up survey to assess the incidence and remission of asthma and allergic rhinoconjunctivitis in order to evaluate whether the earlier increase in incidence of asthma has continued, and to evaluate the impact of allergic rhinoconjunctivitis as a risk factor for incident asthma.

## Material and methods

### Study population

This is a part of a large epidemiological study, which has been in progress in Finland, Estonia, and Sweden (FinEsS) since 1996. The original study population comprised subjects obtained at random from the population registers to represent the general population. The original study population in Helsinki, Finland, included 8000 subjects aged 20–69 years, and 6062 (76%) subjects participated in the first postal questionnaire in 1996.<sup>14</sup> A follow-up study was performed in 2007, and 5484 subjects could be traced out of the original 6062 participants, with the 4302 complete answers obtained giving a response rate of 78% (Table 1). Of the 578 subjects lost to follow-up, 336 were dead, 8 were living abroad, 64 were traced without access to address, and 170 could not be traced. The studies were approved by the ethics committee of Helsinki University Hospital.

### Questionnaire

Our self-administered postal questionnaire<sup>14</sup> with two reminders was originally developed for the first Swedish OLIN survey<sup>15</sup> in 1985 from a revised version<sup>16</sup> of the British Medical Research council questionnaire.<sup>17</sup>

### Definitions

*Ever asthma* refers to the question "Have you ever had asthma?" and *physician-diagnosed asthma* to "Have you been diagnosed as having asthma by a doctor?"

*Allergic rhinoconjunctivitis* refers to "Have you had allergic eye or nose symptoms (hay fever)?"

*Asthma medication:* "Do you currently use asthma medicines (permanently or as needed)?"

*Any wheeze:* "Have you had wheezing or whistling in the chest at any time in the last 12 months?"

*Recurrent wheeze:* "Do you usually have wheezing or whistling in your chest when breathing?"

*Longstanding cough:* "Have you had longstanding cough during recent years?"

**Table 1** Study subjects by gender (M, men; W, women), age group, and smoking category.

	M	W	M	W	M	W	M	W	M	W	M	W
Age in 2007	31–40		41–50		51–60		61–70		71–80		Total	
Invited (n)	516	762	603	768	548	724	377	530	266	390	2310	3174
Participated n	319	553	445	609	420	585	354	515	207	295	1745	2557
Participated (%)	62	73	74	79	77	81	94	97	78	76	76	81
Smokers 1996 (%)	37	34	42	33	31	33	36	23	21	14	35	29
Smokers 2007 (%)	32	21	33	24	24	25	29	18	12	9	27	21
Non-smoker 2007 (%)	48	57	41	51	36	44	31	55	42	70	39	54
Quitters 1996–07 (%)	13	15	12	10	10	8	8	7	10	5	10	9
Starters 1996–07 (%)	8	3	4	2	4	2	2	2	2	<1	4	2

**Shortness of breath:** "Have you had asthma symptoms (intermittent breathlessness) or attacks of breathlessness?" with a further question about having had these symptoms during the previous year.

**Current smoking** refers to those currently or within one year having been smoking cigarettes, pipe or cigars.

**Ex-smokers** are those who quit smoking at least one year previously.

**Quitters** smoked in 1996, but were ex- or non-smokers in 2007.

**Starters** were ex- or non-smokers in 1996, but smokers in 2007.

**Countryside/farm living** refers to those who lived in the countryside/on a farm during the first 5 years of life.

**Family history of asthma** refers to those, whose parents, sisters or brothers have asthma.

**Family history of allergic rhinoconjunctivitis** refers to those, whose parents, sisters or brothers have allergic rhinoconjunctivitis.

**Crude cumulative incidence of asthma** was calculated by excluding from the population at risk those with either physician-diagnosed asthma or ever asthma in 1996, and calculating the proportion of new cases of physician-diagnosed asthma in 2007.

**Cumulative incidence of allergic rhinoconjunctivitis** was calculated by excluding from the population at risk those with the condition in 1996, and calculating new cases in 2007.

**Remission of asthma** refers to those with physician-diagnosed asthma and either use of asthma medication or symptoms of shortness of breath during the previous year or recurrent wheeze in 1996, but without these symptoms and medication in 2007.

**Remission of allergic rhinoconjunctivitis** refers to those who reported allergic rhinoconjunctivitis in 1996, but no longer in 2007.

## Statistical analyses

Statistical analyses were performed with SPSS 15.0, with the chi-square test for bivariate comparisons. Determinants for incident cases of asthma were calculated by multiple logistic regression. These analyses were performed with age group, gender, family history of asthma, allergic rhinoconjunctivitis and smoking categories serving as independent variables. Age group, gender, and family history of

allergic rhinoconjunctivitis served as covariates in calculation of risk factors for incident allergic rhinoconjunctivitis. Multiple logistic regression analysis was used because there was no information of time of events. The incidence rate was assumed to be linear and was calculated using the formula:  $a/(11 \times (b - (a/2)))$  where  $a$  is the incident cases and  $b$  the subjects at risk in 1996. Adjusted cumulative incidence of asthma was calculated after excluding from the population at risk besides those with asthma, also subjects on asthma medication and those who reported physician-diagnosed chronic bronchitis or COPD in 1996. Further adjustment also excluded those reporting recurrent wheeze or shortness of breath during the previous year at baseline in 1996. Crude and adjusted incident rate ratios (IRR) by gender were calculated, and a  $p$ -value  $<0.05$  and a 95% confidence interval were considered significant.

## Results

### Respiratory symptoms and smoking habits

Prevalence of asthma, use of asthma medication, and allergic rhinoconjunctivitis had increased in the cohort from 1996 to 2007, but there was no trend toward any increase in asthma-related symptoms (Table 2). Of all subjects reporting physician-diagnosed asthma in 2007, allergic rhinoconjunctivitis was reported by 78.5%. Current smoking decreased from 31.3% in 1996 to 23.3% in 2007. Smoking decreased in both genders but remained more common in men ( $p < 0.001$ ). Smoking decreased less among

**Table 2** Prevalence of asthma, allergic rhinoconjunctivitis, and respiratory symptoms in 1996 and 2007.

Condition	1996	2007
	(%)	(%)
Physician-diagnosed asthma	6.8	9.4
Asthma medication use	6.1	9.8
Allergic rhinoconjunctivitis	38.0	40.8
Longstanding cough	19.8	19.1
Recurrent wheeze	6.7	6.9
Any wheeze	20.0	18.1
Shortness of breath	13.2	14.8

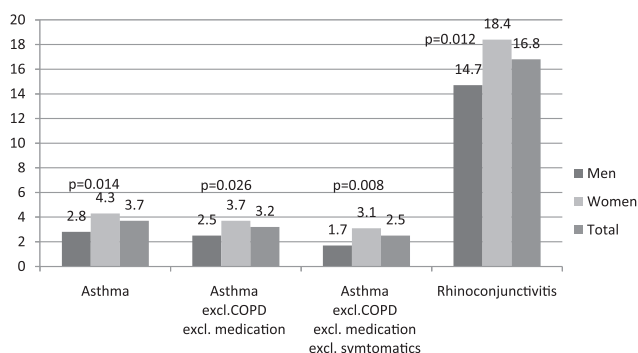
those with physician-diagnosed asthma: from 29.9% to 25.6%.

## Incidence

Totally 157 new asthma cases occurred from 1996 to 2007 corresponding to an incidence rate of 3.7/1000/year and a cumulative 11-year total incidence of 4.0%, 4.6% among women and 3.1% among men ( $p = 0.014$ ). The adjusted cumulative 11-year incidence based on 132 asthma cases, decreased to 3.5%, corresponding to 3.2/1000/year (women 3.7/1000/year; men 2.5/1000/year,  $p = 0.026$ ) with those who used asthma medication and those with physician-diagnosed chronic bronchitis or COPD at baseline excluded. After further excluding those with recurrent wheeze and shortness of breath at baseline from the population at risk, the incidence rate decreased to 2.5/1000/year (Fig. 1).

Of these 132 new asthmatics, defined after excluding those with asthma medication and chronic bronchitis or COPD at baseline, shortness of breath during the previous year was reported by 74.2%, any wheeze by 56.8%, recurrent wheeze by 28.0%, and longstanding cough by 44.7%. Allergic rhinoconjunctivitis was reported by 65.2% of them; 78.0% used asthma medication, and 24.2% were current smokers.

The incident cases of allergic rhinoconjunctivitis from 1996 to 2007 amounted to 447 (173 men; 274 women), with a significantly higher incidence in women ( $p = 0.012$ ). This corresponds to an 11-year cumulative incidence of 16.9% and an incidence rate of 16.8/1000/year (Fig. 1). The highest cumulative incidence of allergic rhinoconjunctivitis, 23.0%, appeared in the youngest age group, with a decreasing trend with increasing age: 18.8% in age group 41–50 years, 15.7% among those aged 51–60; 12.9% between ages 61–70, and 13.8% among those 71–80 years of age ( $p < 0.001$ ). Incidence of allergic rhinoconjunctivitis was 25.9% among those with a family history of allergic rhinoconjunctivitis, and 14.5% among those without



**Figure 1** Annual incidence rate (cases/1000/year) of asthma (AB) and allergic rhinoconjunctivitis by gender and difference ( $p$ -value) by gender. Adjustment 1 excluded from population at risk at baseline in 1996 besides asthmatics also those on asthma medication and those with physician-diagnosed chronic bronchitis or COPD. Adjustment 2 further excluded also those reporting in 1996 recurrent wheeze or shortness of breath during the previous year.

a family history ( $p < 0.001$ ). Smoking was not associated with incident allergic rhinoconjunctivitis. Incidence of allergic rhinoconjunctivitis was significantly lower among those who had lived in the countryside or on a farm during the first 5 years of life compared to those who had not (Fig. 2), while this was not true for asthma. Of those with physician-diagnosed asthma but not allergic rhinoconjunctivitis in 1996, 30.4% developed allergic rhinoconjunctivitis over the following 11 years.

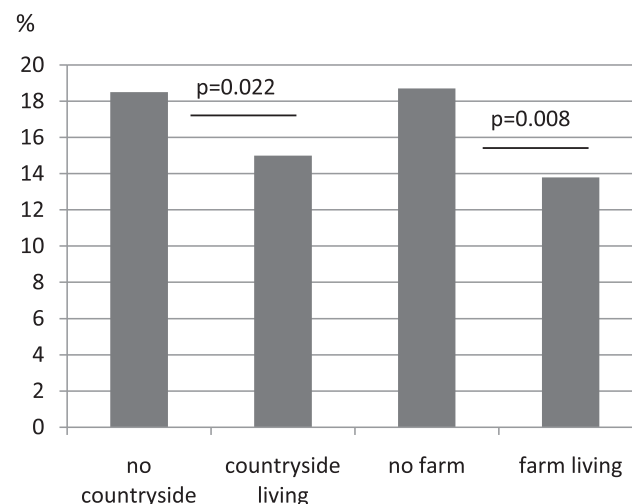
Allergic rhinoconjunctivitis and family history of asthma were both significantly associated with incident asthma (Table 3). Men reporting allergic rhinoconjunctivitis had a 3- to 4-fold higher incidence of asthma than did men without, whereas this effect was less than 2-fold among women. In men, those with a family history of asthma had a 3-fold incidence of asthma, and in women a 2-fold, compared to those without asthma in the family. Gender, smoking habits, and age group were also significantly associated with incident asthma in univariate analyses.

## Remission

Active asthma with current medication or symptoms (shortness of breath during the previous year or recurrent wheeze) was reported by 254 subjects (87 men; 167 women) in 1996. Of these, 43 (17%) were in remission in 2007 with no current use of medication or current symptoms (11 (13%) men; 32 (19%) women,  $p = 0.189$ ). A greater proportion of those with asthma in remission had quit smoking between 1996 and 2007 than those with persistent active asthma, 31% and 27%, respectively (ns). Remission of allergic rhinoconjunctivitis occurred in 296 subjects, corresponding to a cumulative remission over 11 years of 18.1% (men 20.6%; women 16.7%,  $p = 0.06$ ).

## Multivariate analyses

Women were at higher risk for incident asthma than were men (Table 4). Allergic rhinoconjunctivitis doubled the risk



**Figure 2** Cumulative incidence (%) of allergic rhinoconjunctivitis over 11 years by farm and countryside living during the first 5 years of life.

**Table 3** Cumulative incidence of asthma (AB) with IRRs (95% CI) based on univariate analyses by allergic rhinoconjunctivitis (ARC) in 1996, family history of asthma, and smoking categories.

Subjects	Incident asthma <sup>a</sup>				Asthma excluding COPD and AB medication users <sup>b</sup>			
	Subjects at risk 1996 (n)	Cases 2007 (n)	Cumulative incidence (%) 1996–2007	IRR (95% CI)	Subjects at risk 1996 (n)	Cases 2007 (n)	Cumulative incidence (%) 1996–2007	IRR (95% CI)
<b>ARC 1996</b>								
<b>Men</b>								
No	1125	20	1.78	1	1099	16	1.46	1
Yes	501	30	5.99	3.36 (1.91–5.92)	476	26	5.46	3.74 (2.01–6.97)
<b>Women</b>								
No	1449	53	3.66	1	1414	47	3.32	1
Yes	886	54	6.09	1.67 (1.14–2.44)	832	43	5.17	1.56 (1.03–2.36)
<b>Fam.hist. of AB</b>								
<b>Men</b>								
No	1393	33	2.37	1	1350	27	2.00	1
Yes	220	15	6.82	2.88 (1.56–5.30)	213	14	6.57	3.29 (1.73–6.27)
<b>Women</b>								
No	1867	71	3.80	1	1801	61	3.39	1
Yes	445	35	7.87	2.07 (1.38–3.10)	426	29	6.81	2.01 (1.29–3.13)
<b>Smoking 1996</b>								
<b>Men</b>								
Non-smoker	708	10	1.41	1	699	9	1.29	1
Ex-smoker	360	18	5.00	3.55 (1.64–7.69)	353	17	4.82	3.74 (1.67–8.39)
Smoker	554	21	3.79	2.69 (1.43–5.05)	520	16	3.08	2.39 (1.06–5.41)
<b>Women</b>								
Non-smoker	1320	45	3.41	1	1285	38	2.96	1
Ex-smoker	329	24	7.29	2.14 (1.30–3.51)	309	19	6.15	2.08 (1.20–3.61)
Smoker	681	38	5.58	1.64 (1.06–2.53)	647	33	5.10	1.72 (1.08–2.74)

<sup>a</sup> Subjects reporting physician-diagnosed asthma or ever asthma were excluded from the population at risk.

<sup>b</sup> Subjects with physician-diagnosed asthma, ever asthma, physician-diagnosed chronic bronchitis or chronic obstructive pulmonary disease, and users of asthma medication in 1996 were excluded from the population at risk. IRR = incidence rate ratio. CI = confidence interval.

**Table 4** Risks in odds ratios (OR) with 95% confidence intervals (CI) for incidence of asthma (AB) by multiple logistic regression analysis.

Independent variables		Dependent variables	
Variables	Categories	Incident asthma <sup>a</sup> OR (95%CI)	Asthma excluding COPD and AB medication users <sup>b</sup> OR (95%CI)
Age	31–40	1	1
	41–50	0.96 (0.55–1.68)	0.90 (0.50–1.62)
	51–60	1.20 (0.70–2.07)	1.12 (0.63–1.98)
	61–70	1.55 (0.91–2.66)	1.43 (0.81–2.53)
	71–80	2.33 (1.30–4.18)	2.41 (1.31–4.43)
Gender	Men	1	1
	Women	1.53 (1.07–2.20)	1.59 (1.08–2.34)
Family history of asthma	No	1	1
	Yes	2.05 (1.42–2.95)	2.19 (1.49–3.22)
History of allergic rhinoconjunctivitis	No	1	1
	Yes	2.15 (1.54–3.02)	2.00 (1.40–2.87)
Smoking habits 1996	Non-smoker	1	1
	Ex-smoker	2.25 (1.45–3.48)	2.50 (1.58–3.96)
	Smoker	2.00 (1.35–2.96)	2.06 (1.35–3.16)

<sup>a</sup> Subjects reporting physician-diagnosed asthma or ever asthma excluded from the population at risk.

<sup>b</sup> Subjects with physician-diagnosed asthma, ever asthma, physician-diagnosed chronic bronchitis or chronic obstructive pulmonary disease, and users of asthma medication in 1996 excluded from the population at risk.



for incident asthma. Having a family history of asthma and being an ex-smoker or a current smoker also doubled the risk for incident asthma in both models.

The results were similar when the multivariate analyses were performed without allergic rhinoconjunctivitis in the model; Having a family history of asthma yielded an OR 2.28 (95%CI 1.63–3.20) for incident asthma, with an OR 2.41 (95% CI 1.65–3.52) after excluding those with asthma medication and physician-diagnosed chronic bronchitis or COPD at baseline. When family history of asthma was excluded from the model, the magnitude of allergic rhinoconjunctivitis as a risk for incident asthma remained similar, OR 2.13 (95%CI 1.57–2.90), and after exclusion of users of asthma medication and COPD from population at risk: OR 1.97 (95%CI 1.31–2.96).

Having a family history of allergic rhinoconjunctivitis was a significant risk factor for incident allergic rhinoconjunctivitis, OR 1.73 (95%CI 1.34–2.25). Farm living during the first 5 years of life was protective for incident allergic rhinoconjunctivitis, OR 0.75 (95% CI 0.57–0.99). In multivariate analysis, the effect of gender and age did not reach statistical significance.

## Discussion

A high incidence of allergic rhinoconjunctivitis was evident in this 11-year survey, whereas incidence of asthma remained at the same level as in recent studies performed in neighboring countries and in Finland.<sup>4,5,7–9</sup> The annual incidence of rhinoconjunctivitis was 16.8/1000/year and of asthma 2.5 to 3.7/1000/year depending on the criteria of population at risk, both significantly higher for women than for men. The prevalence of allergic rhinoconjunctivitis in the cohort increased slightly from 38.0% to 40.9% between 1996 and 2007. Allergic rhinoconjunctivitis was an independent risk factor for incident asthma, doubling the risk for asthma consistently in different models of analysis.

The advantage of our study is the longitudinal follow-up of a population based cohort. The original study population was a representative sample of the general adult population of Helsinki.<sup>14</sup> The participation rate, 76%, initially obtained in the baseline survey in 1996 was good, with a participation in 2007 even better, 78%, suggesting that the results are representative. A possible bias in questionnaire studies is reliability of the responses. The questionnaire used has been validated in the Swedish OLIN studies.<sup>7,18</sup> Similar questions on ever asthma and physician-diagnosed asthma in another Finnish study yielded a good positive predictive value and a high specificity.<sup>19</sup> Because of the possibility of some misclassification of COPD as asthma, we also calculated the adjusted incidence of asthma excluding those with chronic bronchitis or COPD from the population at risk, and also those on asthma medication at baseline. Diagnosis of allergic rhinoconjunctivitis based on self-reported symptoms may have led to some over-estimation of the condition, but use of the same questions in the follow-up survey allows assessment of the incidence in the large cohort.

The prevalence of symptoms common in asthma remained on similar level in the follow-up survey, but an increase in the cohort occurred in prevalence of physician-diagnosed

asthma and to some extent allergic rhinoconjunctivitis. Current smoking decreased markedly, which was likely to have contributed to the lack of increase of respiratory symptoms despite of increasing age. The national Asthma Programme 1994–2004 probably facilitated diagnostic activity for asthma in Finland, which may at least partly explain the increase in prevalence of asthma in the cohort. During this time period also the ratio of defined daily doses (DDD) of preventive asthma medication exceeded the use of asthma relievers and the proportion of moderate and severe asthma decreased.<sup>1,20</sup> A high goal set in the Allergy Programme was to reduce asthma and allergic rhinitis prevalence by 20% in 10 years, by 2018.<sup>6</sup>

The incidence of asthma ranged from 2.5 to 3.7/1000/year depending on how the population at risk was defined. The incidence was highest when only those with asthma at baseline were excluded. It is a common practice to exclude those with suspected asthma from the population at risk, e.g., those on asthma medication or with asthma-related symptoms at baseline. However, as COPD with some reversibility of airway obstruction may be misdiagnosed as asthma, it is reasonable to exclude also subjects with COPD from the population at risk. Furthermore, in Finland, it is more favorable for the patient to have a diagnosis of asthma than of COPD, because with an asthma diagnosis reimbursement for inhaled medication is much easier to obtain. Reimbursement for asthma requires reversible obstruction, but for COPD a severe obstruction is required, which may lead to favoring asthma diagnosis. Possible misclassification of COPD to asthma may have contributed to the higher incidence of asthma in older age groups, however, data from the Allergy Programme show that incidence of persistent asthma among adults is highest among those aged 70–79 years in Finland.<sup>20</sup>

The incidence of asthma in our study was similar to that in recent reports from Sweden,<sup>7–9</sup> but slightly higher than in earlier Finnish studies.<sup>2,3</sup> Our incidence was close to that reported by Karjalainen et al. from Finland in 2001, with 1.65/1000/year for men and 2.47/1000/year for women.<sup>5</sup> However, prospective population studies generally result in somewhat higher estimates of incidence than do register based studies or retrospective estimates of incidence.<sup>21,22</sup> The study by Karjalainen et al had a large follow-up cohort including nearly 50,000 incident cases of asthma, as it pooled data from national registers for reimbursement of asthma medication and occupational diseases based on diagnoses reported by physicians. A linear increase in asthmatic patients receiving special reimbursement for asthma medication was obvious from the beginning of the 80s until the end of the 90s, probably reflecting an increase in asthma prevalence.<sup>1</sup> Whether a real plateau has been reached remains to be verified. In many European countries, no further increase in asthma prevalence has been noticeable since the about 1990.<sup>8,23,24</sup>

Remission of asthma occurred in 17% during the 11-year follow-up, consistent with recent findings from Stockholm, Sweden, with 15% remission in 10 years,<sup>8</sup> but somewhat higher than in the OLIN studies from northern Sweden.<sup>12,25</sup> OLIN studies associated remission with previously mild disease and cessation of smoking. The decrease in smoking found in our study and the earlier reported decrease in the proportion of moderate to severe asthma in Finland have

probably contributed to the relatively high remission of asthma, possibly together with the increase in preventive asthma medication use.<sup>1</sup>

The incidence of allergic rhinoconjunctivitis was higher than in earlier Finnish studies.<sup>2,4</sup> Our question combines nasal and ocular symptoms, which may result in an increase in positive responses. Some questionnaires assess for rhinitis symptoms without including ocular symptoms. Use of such a questionnaire led to a prevalence similar to ours for allergic rhinitis, 37%.<sup>26</sup> Remission of allergic rhinoconjunctivitis was somewhat lower than in Sweden some years ago, 23% in 8 years.<sup>27</sup> The responses in our study reflect, besides allergic rhinitis, also non-allergic rhinitis, their symptoms being similar. Both forms of rhinitis were significant risk factors for incident asthma in a recent report of the ECRHS,<sup>10</sup> one of the few longitudinal studies assessing the impact of allergic rhinitis on risk for developing asthma.<sup>2,28</sup> Our finding of 2-fold risk for incident asthma among those with allergic rhinoconjunctivitis was consistent with these findings. We found a lower incidence of allergic rhinoconjunctivitis among those who had lived in the countryside or on a farm during the first 5 years of life, which confirms similar results of a recent study from Sweden.<sup>29</sup> This association remained in the multivariate setting for farm living.

In multivariate analyses, both allergic rhinoconjunctivitis and smoking were, besides genetic factors, highlighted as risk factors for incident asthma. The effect of smoking was stronger and that of genetic factors weaker in our study than in Sweden.<sup>8</sup> This may be explained by differences in smoking habits between the countries; overall smoking was more common in Finland and further, there were more heavy smokers in Finland, thus contributing to a greater extent to new onset of asthma. That former smoking was a stronger risk factor for asthma is consistent with earlier findings.<sup>30</sup> Family history of allergic rhinoconjunctivitis nearly doubled the risk for incident allergic rhinoconjunctivitis, which reflects the importance of genetic predisposition in allergic diseases. On the other hand, allergic rhinoconjunctivitis yielded a similar doubled risk for incident asthma even with family history of asthma in the analyses, underlining the independent and strong effects of rhinitis on asthma.

The impact of allergic rhinitis on asthma is largely acknowledged today, and guidelines stress the importance of treating both for patient well being.<sup>13</sup> The nasal and bronchial mucosa share similar inflammatory changes in allergic patients, but for an unknown reason, epithelial shedding is more pronounced in the bronchi.<sup>31</sup> Allergen-specific immunotherapy for allergic rhinitis has the potential to prevent the onset of asthma in children.<sup>32</sup> Being common and affecting the health-related quality of life, allergic rhinitis deserves more attention and resources in health care.<sup>33</sup>

In conclusion, we found a high prevalence and a high incidence of allergic rhinoconjunctivitis. Living on a farm in childhood yielded a lower risk of having allergic rhinoconjunctivitis. Incidence of asthma was similar to results from recent studies in Sweden and other Scandinavian countries. Allergic rhinoconjunctivitis was an important risk factor for incident asthma of the same magnitude as having a family history of asthma. More focus should be upon

studying allergic rhinitis, to assess whether optimal treatment could reduce the burden of allergic rhinitis and possibly prevent the onset of asthma.

## Conflict of interest

There are no conflict of interest for any of the authors of the manuscript: "Allergic rhinoconjunctivitis doubles the risk for incident asthma – results from a population study in Helsinki, Finland."

## Acknowledgments

The study was supported by grants from the Allergy Foundation in Finland, the Foundation of the Finnish Anti-Tuberculosis Association and the Ida Montin Foundation. We acknowledge the valuable assistance of Mrs Kerstin Ahlskog, Mrs Kirsi Sariola, and Mrs Helena Andersson.

## References

1. Haahtela T, Klaukka T, Koskela K, Erhola M, Laitinen LA. Asthma programme in Finland: a community problem needs community solutions. *Thorax* 2001;**56**:806–14.
2. Huovinen E, Kaprio J, Laitinen LA, Koskenvuo M. Incidence and prevalence of asthma among adult Finnish men and women of the Finnish twin cohort from 1975 to 1990, and their relationship to hay fever and chronic bronchitis. *Chest* 1999;**115**:928–36.
3. Reijula K, Haahtela T, Klaukka T, Rantanen J. Incidence of occupational asthma and persistent asthma in young adults has increased in Finland. *Chest* 1996;**110**:58–61.
4. Huurre TM, Aro HM, Jaakkola JJ. Incidence and prevalence of asthma and allergic rhinitis: a cohort study of Finnish adolescents. *J Asthma* 2004;**41**:311–7.
5. Karjalainen A, Kurppa K, Martikainen R, Klaukka T, Karjalainen J. Work is related to a substantial portion of adult-onset asthma incidence in the Finnish population. *Am J Respir Crit Care Med* 2001;**164**:565–8.
6. Haahtela T, von Hertzen L, Mäkelä M, Hannuksela M. Finnish Allergy Programme 2008–2018 – time to act and change the course. *Allergy* 2008;**63**:634–45.
7. Lundbäck B, Rönmark E, Jönsson E, Larsson K, Sandström T. Incidence of physician-diagnosed asthma in adults – a real incidence or a result of increased awareness? Report from the Obstructive Lung Disease in Northern Sweden Studies. *Respir Med* 2001;**95**:685–92.
8. Ekerljung L, Rönmark E, Larsson K, Sundblad B-M, Bjerg A, Ahlstedt S, Dahlen S-E, Lundbäck B. No further increase of incidence of asthma: incidence, remission and relapse of adult asthma in Sweden. *Respir Med* 2008;**102**:1730–6.
9. Torén K, Gislason T, Omenaas E, Jögi R, Forsberg B, Nyström L, Olin A-C, Svanes C, Janson C. A prospective study of asthma incidence and its predictors: the RHINE study. *Eur Respir J* 2004;**24**:942–6.
10. Shaaban R, Zureik M, Soussan D, Neukirch C, Heinrich J, Sunyer J, Wjst M, Cerveri I, Pin I, Bousquet J, Jarvis D, Burney PG, Neukirch F, Leynaert B. Rhinitis and onset of asthma: a longitudinal population-based study. *Lancet* 2008;**372**:1049–57.
11. Holm M, Omenaas E, Gislason T, Svanes C, Jögi R, Norrman E, Janson C, Torén K. Remission of asthma: a prospective study from northern Europe (RHINE study). *Eur Respir J* 2007;**30**:62–5.

12. Rönmark E, Lindberg A, Watson L, Lundbäck B. Outcome and severity of adult onset asthma – Report from the obstructive lung disease in northern Sweden studies (OLIN). *Respir Med* 2007;**101**:2370–7.
13. Bousquet J, Khaltaev N, Cruz AA, et al. Allergic rhinitis and its impact on asthma (ARIA) 2008 update. *Allergy* 2008;**63**(Suppl. 86):8–160.
14. Pallasaho P, Lundbäck B, Läspä SL, Kotaniemi J, Sovijärvi ARA, Laitinen LA. Increasing prevalence of asthma but not of chronic bronchitis in Finland? Report from the FinEsS-Helsinki study. *Respir Med* 1999;**93**:798–809.
15. Lundbäck B, Nyström L, Rosenhall L, Stjernberg N. Obstructive lung disease in northern Sweden: respiratory symptoms assessed in a postal survey. *Eur Respir J* 1991;**4**:257–66.
16. Mikaelsson B, Stjernberg N, Wiman LG. Prevalence of bronchial asthma and chronic bronchitis in an industrial community in northern Sweden. *Scand J Soc Med* 1982;**10**:11–6.
17. Medical Research Council's committee on the aetiology of chronic bronchitis – standardized questionnaires on respiratory symptoms. *Br Med J* 1960;**ii**:1665.
18. Lundbäck B. Asthma, chronic bronchitis and respiratory symptoms: prevalence and important determinants. The Obstructive Lung Disease in Northern Sweden Study I. Umeå University Medical Dissertation 1993.
19. Kilpeläinen M, Terho EO, Helenius H, Koskenvuo M. Validation of a new questionnaire on asthma, allergic rhinitis and conjunctivitis among young adults. *Allergy* 2001;**56**:377–84.
20. Haahtela T, Tuomisto LE, Pietinalho A, Klaukka T, Erhola M, Kaila M, Nieminen MM, Kontula E, Laitinen LA. A 10 year asthma programme in Finland: major change for the better. *Thorax* 2006;**61**:663–70.
21. Vesterinen E, Kaprio J, Koskenvuo M. Prospective study of asthma in relation to smoking habits among 14 729 adults. *Thorax* 1988;**43**:534–9.
22. Strachan DP, Butland BK, Anderson HR. Incidence and prognosis of asthma and wheezing illness from early childhood to age 33 in a national British cohort. *Br Med J* 1996;**312**:1195–9.
23. Anderson HR, Gupta R, Strachan DP, Limb ES. 50 years of asthma: UK trends from 1955 to 2004. *Thorax* 2007;**62**:85–90.
24. Lötvalld J, Ekertjung L, Rönmark EP, Wennergren G, Lindén A, Rönmark E, Torén K, Lundbäck B. West Sweden Asthma Study: prevalence trends over the last 18 years argues no recent increase in asthma. *Respir Res* 2009 Oct 12;**10**:94.
25. Rönmark E, Jönsson E, Lundbäck B. Remission of asthma in the middle aged and elderly: report from the Obstructive Lung Disease in Northern Sweden study. *Thorax* 1999;**54**:611–3.
26. Hedman J, Kaprio J, Nieminen MM. Prevalence of asthma, aspirin intolerance, nasal polyposis and chronic obstructive pulmonary disease in a population-based study. *Int J Epidemiol* 1999;**28**:717–22.
27. Nihlén U, Greiff L, Montnémy P, Löfdahl C-G, Johansson A, Persson C, Andersson M. Incidence and remission of self-reported allergic rhinitis symptoms in adults. *Allergy* 2006;**61**:1299–304.
28. Guerra S, Sherrill DL, Martinez FD, Barbee RA. Rhinitis as an independent risk factor for adult-onset asthma. *J Allergy Clin Immunol* 2002;**109**:419–25.
29. Eriksson J, Ekertjung L, Lötvalld J, Pullerits T, Wennergren G, Rönmark E, Torén K, Lundbäck B. Growing up on a farm leads to lifelong protection against allergic rhinitis. *Allergy* 2010;**65**:1397–403.
30. Piipari R, Jaakkola JJK, Jaakkola N, Jaakkola MS. Smoking and asthma in adults. *Eur Respir J* 2004;**24**:734–9.
31. Chanez P, Vignola AM, Vic P, Guddo F, Bonsignore G, Godard P, Bousquet J. Comparison between nasal and bronchial inflammation in asthmatic and control subjects. *Am J Respir Crit Care Med* 1999;**159**:588–95.
32. Niggemann B, Jacobsen L, Dreborg S, Ferdousi HA, Halken S, Host A, et al. five-year follow-up on the PAT study: specific immunotherapy and long-term prevention of asthma in children. *Allergy* 2006;**61**:855–9.
33. Canonica GW, Bousquet J, Mullol J, Scadding GK, Virchow JC. A survey of the burden of allergic rhinitis in Europe. *Allergy* 2007;**62**(Suppl. 85):17–25.