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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

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Abstract Only limited data are available about the incidence of asthma based on longitudinal prospective studies. Further, the results from different studies on incidence vary considerably depending on the age composition of the cohorts under study, the used methods and the criteria for disease. Also among adults high incidence rates have been reported during recent years. The aim of this study was to examine to what extent the incidence of physician-diagnosed asthma could be explained by a real incidence of the disease, and to what extend by an increased diagnostic activity or altered diagnostic praxis. Another aim was to study risk factors for asthma based on incident cases. Three cross-sectional surveys have been performed in the same population sample living in the northern-most province of Sweden, Norrbotten. The first survey was performed in 1986, and 5698 subjects, 86% of those invited, responded to a postal questionnaire. Of these, 4754 subjects (83%) participated at the third survey in 1996. After exclusion of all subjects who had reported that they had asthma in 1986, or had been classified as having asthma in 1986, 68 men and 98 women (P=0·02) reported in 1996 that they had been diagnosed as having asthma by a physician. Thus, the cumulative incidence for the 10-year period was 3·2% among men and 4·5% among women. After correction for subjects who already in 1986 had reported symptoms common in asthma, or had been classified as having chronic bronchitis, 97 subjects with incident asthma remained, which corresponded to an annual incidence rate among men of 1·7 and among women of 2·9/1000 persons year^{-1} (P=0·01). Clinical examinations confirmed asthma in a large majority of these 97 subjects. Significant risk factors were family history of asthma, both ex- and current smoking, and female sex. The socio-economic groups manual workers and assistant non-manual employees were associated with incident asthma, although not significantly. The increasing prevalence of asthma among adults during recent 10–20 years may to a considerable extent be explained by an increased diagnostic activity or altered diagnostic praxis. Use of different methods when measuring incidence may in part explain the extremely diverging incidence rates of asthma found in different studies.

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INTRODUCTION

Whereas numerous cross-sectional studies of respiratory symptoms and diseases have been reported during the last decades, results from longitudinal studies, particularly among adults, are still limited. When studying risk factors, which are not constant over a life-time or over long periods, longitudinal studies give more valid information than do cross-sectional studies. When studying diseases with a low incidence, it is necessary to follow large population samples for long periods to get sufficient numbers of incident cases to be able to calculate risks.

Cohort studies of general population samples or cross-sectional follow-ups of cohorts have been performed mainly in children, teenagers and young adults

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(1–6). In adults, only a few longitudinal population studies have been focused on asthma (2,3,7), or on wheezing conditions (8). The incidence rates from these studies vary considerably.

The Obstructive Lung Disease in Northern Sweden Studies (OLIN) started as a prevalence study in 1986 (9). The study base expanded in 1992, when the cohort from 1986 was also re-examined (10). The third survey of the cohort was performed in 1996. The incidence of physician-diagnosed asthma was estimated to 5/1000 year^{-1} in the 6-year follow-up (10). An important aim with the third follow-up was to examine to what extent the incidence of physician-diagnosed asthma could be explained by a real incidence of the disease, and to what extent by increased awareness of asthma in society, an increased diagnostic activity and altered diagnostic praxis. Another aim was to study risk factors for asthma based on incident cases.

MATERIAL AND METHODS

Three cross-sectional surveys have been performed in the same population sample living in the northern-most province of Sweden, Norrbotten, which comprises one-quarter of the area of Sweden. The first postal questionnaire survey was performed in December 1985 to March 1986 (9), the second in winter 1992 (10) and the third in winter 1996. The studies were approved by the Ethical Committee at the University and the University Hospital of Northern Sweden in Umeå.

Study population

In the first survey all 6610 subjects born in 1919–1920, 1934–1935 and 1949–1950 living in eight representative areas of the province were invited. The subjects and their addresses were provided by the provincial authorities from the Swedish Population Register. Completed answers were received from 5698 subjects (86%). The first postal questionnaire survey was followed by lung function tests and structured interviews (11), and a validation study of the results of the questionnaire and the interviews (12).

The 1992 study population consisted of 6215 subjects, as 265 subjects had died and 130 subjects could not be traced, therefore 5393 (87%) participated (10). In 1996, the study population comprised 5933 subjects. The mortality had increased mainly in the oldest age group, in which 30% of men and 16% of women had died. In total, 574 subjects had died, 99 had moved abroad and four could not be traced. During the study another 13 had deceased, 26 had dementia or suffered from other severe medical conditions and another two had moved abroad. Of the remaining 5892 subjects complete responses were received from 5189 subjects (88%), or 79% of the original study cohort from December 1985. Of the 1986 year study participants, 4754 (83%) subjects participated (Table 1).

METHODS

The same questionnaire, with a few exceptions, was used in the three surveys. The questionnaire was developed for the first OLIN survey in 1986 from a revised version (13) of the British Medical Research Council questionnaire (14). It has later been used in several Swedish (4,15) and Northern European studies (16). The questions about respiratory symptoms and diseases included the symptoms recurrent wheeze, attacks of shortness of breath, long-standing cough, sputum production, chronic productive cough, symptoms in special circumstances or due to different exposures, and asthma, allergic rhinitis, chronic bronchitis or emphysema, and use of asthma medicines. Further, questions about smoking habits, occupation and family history of the diseases were asked for.

Definitions

Asthma was classified according following questions: 'Have you ever had asthma?' (ever asthma) and 'Have you been diagnosed as having asthma by a doctor?' (physician-diagnosed asthma).

The question about use of asthma medicines was as follows: 'Do you currently use asthma medicines (permanently or as needed)?' and the questions about the symptoms used in the analyses were: recurrent wheeze: 'Do you usually have wheezing, whistling (or a noisy sound) in your chest when breathing?'; attacks of shortness of breath (SOB): 'Do you now have or have you had asthma symptoms during the last 10 years (intermittent breathlessness or attacks of shortness of breath; the symptoms may exist simultaneously with or without cough or wheezing)?'. Positive methacholine test was defined as $PC_{20} < 4$ mg ml^{-1} methacholine cloride (12). The method used had been calibrated against a well-established method described by Juniper *et al*. (17). Asthma with spirometric airflow limitation: Subjects with the FEV_1/VC-ratio $< 70\%$ and $FEV_1 < 80\%$ of predicted values, which are the spirometric criteria for COPD according to the British Thoracic Society (BTS) guidelines (18), and with a present history in accordance with asthma.

Incidence

The cumulative incidence is the proportion of subjects without the studied condition at the beginning of the follow-up period who developed the condition during the period under study. The calculations of the incidence of asthma were based on the first and the third postal

Table 1. Study samples. Invited and participants in 1986 and 1996, respectively, by age and sex

	1919–1920		1934–1935		1949–1950		All		Total
Study population	M	F	M	F	M	F	M	F	
Invited in 1986 (*n*)	884	917	1041	1019	1447	1302	3372	3238	6610
Participants in 1986 (*n*)	782	764	922	904	1202	1124	2906	2792	5698
in (%) of the invited	(88)	(83)	(89)	(89)	(83)	(86)	(86)	(86)	(86)
Invited in 1996 (*n*)	616	762	962	956	1380	1257	2958	2975	5933
Participants in 1996	537	646	874	874	1155	1103	2566	2623	5189
in (%) of the invited	(87)	(85)	(91)	(91)	(84)	(88)	(87)	(88)	(87)
Participants both in 1986 and 1996	499	591	807	820	1035	1002	2341	2413	4754
in (%) of the participants 1986	(64)	(77)	(88)	(91)	(86)	(89)	(81)	(86)	(83)

questionnaire surveys in 1986 and 1996, respectively, expressing a 10-year cumulative incidence of physician-diagnosed asthma. An exact annual incidence rate of asthma was not possible to calculate, however, the mean annual cumulative incidence of asthma does indicate the size of the incidence rate, as the remission rate of asthma in adults is very low (19,20).

Analyses

The cumulative incidence of physician-diagnosed asthma for the 10-year follow-up period was first calculated after exclusion of all subjects who in the postal questionnaire in 1986 had reported that they had either ever asthma, or physician-diagnosed asthma, or in the clinical part of the 1986 year study were classified as having asthma. Further, subjects classified in 1986 as having both asthma and chronic bronchitis/COPD (prevalence 0·6% in 1986), or suspected asthma (prevalence 1·0% in 1986) were excluded, which means a history in accordance with asthma, but in whom a physiological verification of the diagnosis of asthma could not be made.

In the next two steps bias caused by increased diagnostic activity, or altered diagnostic praxis or criteria, was corrected by excluding subjects who in 1986 did not have asthma but had other respiratory conditions. First, all subjects among the incident cases with physician-diagnosed asthma, who remained after the previously described calculations, who had been classified as having chronic bronchitis in the clinical part of the 1986 year study, were excluded. Second, subjects who, in the 1986 year study, reported that they had either recurrent wheeze, attacks of shortness of breath, or were using asthma medicines, were excluded.

The remaining subjects with an incident asthma were examined clinically by structured interview and lung function tests in order to assume that they really had asthma. Among them the subjects in the youngest age cohort were also invited to a methacholine test.

Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS) at the National Institute for Working Life. Chi-square test and analysis of variance (ANOVA) were used for uni- and bivariate calculations.

Determinants for incident cases of physician-diagnosed asthma were calculated by multiple logistic regression analysis. The independent variables used in the model were age, sex, family history of asthma, smoking habits, population density, coastal or interior area of domicile, and socio-economic group based on profession (21). Subjects who currently smoked every week or had stopped smoking within 12 months prior to a study were classified as smokers, while those who had stopped smoking more than 12 months previously were classified as ex-smokers. Smoking habits at the start of the follow-up period were used in the risk factor analyses. In addition, the results were re-calculated also when using the smoking habits at the end of the period as independent variables.

RESULTS

Incidence

After exclusion of all subjects who had reported that they had asthma in 1986 or had been classified as having asthma in 1986, 68 men and 98 women ($P=0{\cdot}02$) reported in 1996 that they had been diagnosed as having asthma by a physician. Thus the cumulative incidence for the 10-year period was 3·2% among men and 4·5% among women. Of the 166 subjects, 90% were using asthma medicines, 93% reported attacks of shortness of breath, and 98% reported either use of asthma medicines, recurrent wheeze or attacks of shortness of breath (Table 2).

Among the 166 incident cases with a physician-diagnosed asthma, 39 subjects had been classified as having chronic bronchitis in the 1986 survey. Six of the 39 were from the youngest age cohort, while 33 were from the two elderly cohorts, 31 were current or ex-smokers and

19 were men. All 39 still reported bronchitic symptoms, and all except three reported recurrent wheeze.

Of the remaining 127 incident cases of physician-diagnosed asthma, none had used asthma medicines prior to the 1986 year survey, but 13 men and 17 women had already in 1986 had either attacks of shortness of breath or recurrent wheeze.

After correction for the subjects who were classified as having chronic bronchitis in 1986, or who had reported symptoms common in asthma in 1986, the number of incident cases of physician-diagnosed asthma decreased to 97 subjects, 36 men, corresponding to a cumulative incidence of 2·2% and a mean annual incidence rate of physician-diagnosed asthma of 2·3/1000 persons under risk year^{-1} (Table 2). The incidence among men was 1·7/1000 year^{-1}, and among women was 2·9/1000 year^{-1} (P=0·01).

Clinical data

Of the 97 subjects, 90 (93%) reported attacks of shortness of breath and 88 (91%) were currently using asthma medicines. Eighty of the 97 attended clinical examinations. Of the 80 subjects, all but six (93%) reported a history of asthma with attacks of shortness of breath or wheezing in special circumstances or due to different exposures. Of the remaining six, five currently used asthma medicines, and four of them reported both wheezing and use of asthma medicines. Thirteen had a FEV_1/VC ratio $<70\%$, of whom nine had FEV_1 $<80\%$ of predicted values, and three of them reported chronic productive cough. Thus, in addition to a clinical feature of asthma, nine of the 80 also fulfilled the spirometric criteria for the BTS definition of COPD (18).

Of the 97 incident asthmatics 49 belonged to the youngest age cohort, and they were invited to a methacholine test. Of the 49, one had died after the questionnaire survey, four had moved outside the province, and eight had no possibility to participate or could not be reached. Examinations could not be performed in five subjects due to severe asthma in one subject, severe lung function impairment in one subject, two subjects were using β-receptor antagonists and one subject had recently undergone surgery. Thus, 31 subjects attended the examinations and 29 were methacholine tested. Twenty-three subjects reacted with a $PC_{20}<2$ mg ml^{-1}, further three <4 mg ml^{-1}, and one <8 mg ml^{-1}. Of the two who did not react at 8 mg ml^{-1}, none were using inhaled corticosteroids, but both reported intermittent asthma symptoms and current use of bronchodilators. One of the 31 subjects had FEV_1 $<60\%$ of predicted when attending the examination, why a reversibility test was performed, and FEV_1 increased with 20%. In another of the 31 subjects airway variability by PEF measurements was documented in the case records.

Multivariate relationships

Risk factors for asthma were calculated on different levels (Table 3), first when all 166 incident cases with physician-diagnosed asthma was used in the model. Significant risk factors were family history of asthma, OR 4·68 (95%

Table 2. Measures of incidence of physician-diagnosed asthma by age and sex: number of incident cases, crude and corrected cumulative incidence between 1986 and 1996, and calculated annual incidence rate. Number of symptomatics and users of medicines

	Year of birth									
	1919–1920		1934–1935		1949–1950		All		Total	
Measures of incidence	M	F	M	F	M	F	M	F	*n*	(%)
Incident cases (*n*),	22	20	24	36	22	42	68	98	166	
of which: using asthma medicines*	20	18	20	31	20	40	60	89	149	(90)
reporting attacks of SOB†	20	18	24	30	21	41	65	89	154	(93)
* or † or wheezing	21	20	24	34	21	42	66	96	162	(98)
Crude cumulative incidence (%)	4·8	3·8	3·2	4·9	2·3	4·6	3·2	4·5	3·8	
Incident cases, bronchitis in 1986 excluded (*n*)	10	17	18	24	21	37	49	78	127	
Incident cases, also asthma symptoms in 1986 excluded (*n*),	8	13	11	16	17	32	36	61	97	
of which: using asthma medicines*	6	12	9	15	15	31	30	58	88	(91)
reporting attacks of SOB†	8	12	11	12	16	31	35	55	90	(93)
* or † or wheezing	8	13	11	15	16	32	35	60	95	(98)
Cumulative incidence (%)	1·8	2·5	1·5	2·2	1·8	3·5	1·7	2·8	2·2	
Incidence (*n*/1000 persons year^{-1})	1·8	2·5	1·5	2·2	1·8	3·6	1·7	2·9	2·3	

CI 3·31–6·62), ex- and current smoking, OR 2·50 (95% CI 1·59–3·94) and 2·61 (95% CI 1·69–4·03), respectively, and female sex, OR 1·47 (95% CI 1·03–2·09). After exclusion of the 39 subjects classified as having bronchitis prior to their asthma diagnosis, the risk factor pattern remained similar, however, the impact of smoking decreased and OR for both ex- and current smoking became close to 1·9.

When also the 30 subjects who had reported symptoms associated with asthma at the 1986 year survey were excluded from the analyses, both ex-smoking, OR 2·30 (95% CI 1·29–4·11), and current smoking, OR 2·17 (95% CI 1·25–3·79), were significant risk factors. The impact of family history of asthma, OR 5·53 (95% CI 3·50–8·75), and female sex, OR 1·78 (95% CI 1·12–2·84), became even more pronounced. Living in the interior of the province, compared with area of domicile at the coast, was associated with an increased risk in all analyses, OR 1·30–1·46, however, not significantly so. Population density had no significant influence on the incidence of asthma.

When performing the analyses by using current smoking habits at the end of the follow-up period, 1996, as independent variables in the logistic model, the influence of current smoking decreased. Several smokers had stopped smoking since 1986, and the OR for current smoking as a risk factor for asthma varied from 1·96 (95% CI 1·24–3·11) to 1·57 (95% CI 0·87–2·84) in the analyses. The corresponding figures for ex-smoking varied from 2·26 (95% CI 1·51–3·39) to 1·88 (95% CI 1·11–3·17).

Among the socio-economic groups, the group manual workers in industry was a significant risk factor for asthma, OR 1·76 (95% CI 1·01–3·09), when the calculations were performed when using all 166 incident asthma as the dependent variable, and the group with a lowest risk, professionals and executives, was chosen for comparison. When the bronchitic subjects were excluded, the OR even increased to 1·91 (95% CI 0·98–3·73), but when also those with asthma-related symptoms in 1986 were excluded, the OR decreased to 1·61 (95% CI 0·73–3·56) (Table 4).

Undiagnosed incident asthma

The number of undiagnosed cases of incident asthma was difficult to estimate. Sixty-five subjects reported in the 1996 questionnaire recurrent wheeze, attacks of shortness of breath, and either regular or occasional use of asthma medicines without having used asthma medicines or reported the symptoms in 1986. Of these, 41 were from the two oldest age cohorts, and all but seven of the 41 had in 1986 reported that they had chronic bronchitis or were classified as having chronic bronchitis in the 1986 study. Six of the reminding seven subjects had a history in accordance with asthma, and one was more likely to have COPD. Of the 24 subjects in the youngest age cohort, 12 had been free from respiratory symptoms in 1986. Thus, totally 18 subjects were considered to have a probable incident asthma, which corresponds to an increase of the cumulative incidence of asthma from 1986 to 1996 with 0·4%. Mild symptomatics have not been considered in these calculations.

DISCUSSION

Although still relatively few, the studies reporting the incidence of asthma among adults have shown an extre-

Table 3. Effects of different independent variables on cumulative incidence of asthma 1986–1996 before (uncorrected) and after (corrected) exclusion of subjects with respiratory conditions or symptoms in 1986. Odds ratios (OR) were calculated by multiple logistic regression analysis

Independent variables		Dependent variables			
		Un-corrected incidence of asthma		Corrected incidence of asthma	
Variables	Categories	OR	95% CI	OR	95% CI
Age	Born 1949–1950	1		1	
	1934–1935	1·52	1·02–2·26	1·19	0·66–2·15
	1919–1920	2·12	1·35–3·32	0·84	0·50–1·42
Sex	Men	1		1	
	Women	1·47	1·03–2·09	1·78	1·12–2·84
Family history of asthma	No	1		1	
	Yes	4·68	3·31–6·62	5·53	3·50–8·75
Smoking habits	Non-smoker	1		1	
	Ex-smoker	2·50	1·59–3·94	2·30	1·29–4·11
	Smoker	2·61	1·69–4·03	2·17	1·25–3·79
Area of domicile	Coastal	1		1	
	Inland	1·30	0·92–1·83	1·46	0·94–2·28

Table 4. Relation between different socio-economic groups and cumulative incidence of asthma before (uncorrected) and after (corrected) exclusion of symptomatics in 1996. Odds ratios (OR) were calculated by multiple logistic regression analysis corrected for age, sex, family history of asthma, smoking habits, and area of domicile

Independent variables	Dependent variables			
	Un-corrected incidence of asthma		Corrected incidence of asthma	
Socio-economic groups	OR	95% CI	OR	95% CI
Professionals and higher civil servants	1		1	
Manual workers in industry	1·76	1·01–3·09	1·61	0·73–3·56
Manual workers in service	1·30	0·78–2·17	1·69	0·87–3·27
Assistant non-manual employees	1·28	0·72–2·30	1·79	0·86–3·73
House wives	0·56	0·16–1·96	0·87	0·18–4·18
Self-employees other than professionals	1·39	0·51–3·78	1·19	0·26–5·45

mely wide range of results. The incidence rates reported in literature show a range between 0·4–11/1000 persons under risk year^{-1}, largely depending on the age composition of the cohorts under study, and the methods used. When including the incidence of asthma among adolescents, the range increases to 0·4–14/1000 year^{-1}.

The remission rate of asthma in middle aged and elderly is very low (19,20), and asthma may be regarded more or less as a chronic disease. Thus the annual incidence rate can be calculated from the cumulative incidence. The definition of asthma used was a report of asthma diagnosed by physician, a criterion for asthma often used in epidemiology (22,23).

This study exemplifies the obvious dependency of the methods used when measuring the incidence of asthma. In the first follow up of the cohort by a postal questionnaire in 1992, the crude incidence rate of a reported physician-diagnosed asthma was 8/1000 persons under risk year^{-1} (10). When the results from this 10-year follow-up study were corrected for subjects, who at the start of the follow-up period in 1986 had a clinically and physiologically defined asthma, but who prior to the 1986 study not were aware of that they had asthma, the mean annual incidence rate was 4/1000 persons year^{-1}.

A substantial proportion of those who had been diagnosed as having asthma after 1986, already in 1986 reported recurrent wheeze, attacks of shortness of breath, had used asthma medicines, or had been diagnosed as having chronic bronchitis. This indicates an increased diagnostic activity or partly an altered diagnostic praxis during the last decade. Further, symptoms of asthma may be present many years before the diagnosis of the disease, results also shown by others (24). After exclusion of these in 1986 symptomatic subjects, 97 incident asthmatics remained, corresponding to an incidence rate of 2·3/1000 persons year^{-1}.

With a few exceptions, clinical examinations confirmed a history of asthma in the 97 subjects. A few were more or less free from symptoms and some (nine) subjects fulfilled also the BTS' spirometric criteria for COPD (18). The diagnosis of asthma was validated by methacholine tests among the youngest subjects. More than 90% of the tested subjects were hyper-reactive. In epidemiological studies a considerably lower proportion of subjects classified as having asthma have generally been found to be hyper-reactive (25,26). Including un-diagnosed asthmatics, our results indicate that the incidence rate of asthma was 2–3/1000 persons year^{-1} in this middle aged and elderly cohort.

To what extent may the results had influenced prevalence of asthma in adults? We assume the incidence was of similar order of magnitude in younger adults (3,27), further, that remission of asthma in adults was around 1% (20), and slightly greater among young adults (19), and mortality among the asthmatics was slightly greater or similar to that in society. Thus a change in prevalence of current asthma among adults would be explained by the asthmatics with onset of asthma before they reached adulthood. If 10–12% of those who every year reach adulthood have asthma, the increase in prevalence during the 10-year period would have been around 1% unit.

No difference in the incidence of asthma between the three age cohorts was found. As found by others, no major differences by age occur after reaching adulthood (2,3,27). Regarding gender differences, female sex was a significant risk factor for incident asthma, a result also shown by others (28,29). From puberty, incidence of asthma becomes more common in women (1–4,30).

In some studies, high incidence rates, 2–10/1000 persons year^{-1} have been reported in similar ages as our population (2,3,28,30), but also lower incidence rates have been found compared with our results (7,31–33). In general, our results must be judged as somewhat high when compared with earlier longitudinal cohort studies.

In a study from Finland the incidence was estimated prospectively from 1975 to 1981, and also by linking the study sample to a register including data about hospital admissions. The incidence of asthma was

1·5/1000 persons year^{-1}, while the incidence of hospital admissions was a half that (33). Register studies and retrospectively made estimates of incidence generally results in lower incidence rates than prospective cohort studies.

The incidence of asthma or wheezing in a British cohort from birth to age 33 was 13/1000 persons year^{-1} (6). The incidence measured retrospectively in the same cohort by recalling asthma or wheeze when interviewed at age 33 yielded an incidence of 9/1000 year^{-1}. Thus, a large proportion had forgotten their asthma in childhood. Results from a retrospective study performed in Sweden (34) conforms with the British retrospectively collected results, showing the incidence to be very low in remote periods probably due to forgetfulness, while the incidence during recent years was of similar magnitude as found by others.

As found in our 6-year follow-up study (10), the two main risk factors for incident asthma were family history of asthma and smoking. The odds ratio for a family history of asthma varied from 3·5 to 5·5; the latter was reached after exclusion of the subjects with former chronic bronchitis and those who did not have a real incident asthma. The influence of family history in this middle-aged and elderly cohort must be regarded as surprisingly high, and greater than found in cross-sectional studies among both children (35,36) and adults (16).

Smoking habit as a risk factor for asthma appeared differently in this longitudinal study compared with results from cross-sectional studies often showing ex- or ever smoking to be associated with asthma (33,37,38). Both current smoking and ex-smoking was significantly associated with incident asthma yielding similar odds ratios of around 2. If the smoking habits from 1996 had been used as independent variables in the logistic model when performing risk factor analyses, the influence of current smoking would appear lower, as some smokers had became ex-smokers. Studies of incidence of asthma among teenagers or adolescents have shown current smoking to be a risk factor for asthma (4–6). Only a very few studies among adults have shown this relationship (3,34). Other studies on incidence (7,31) and prevalence (39) have shown no, or even inverse, relationship between smoking and asthma.

Among other examined risk factors, the socio-economic group manual workers in industry was significantly associated with incident asthma before excluding the subjects who were symptomatic in 1986. Manual workers in service and assistant non-manual employees were also related to incident asthma, however not significantly. Population density or area of domicile had no influence on the incidence of asthma in our study.

In conclusion, approximately a half of the subjects with an incident physician-diagnosed asthma had a real incident asthma, which from 1986 to 1996 was estimated at 2–3/1000 persons year^{-1}. Significant risk factors were family history of asthma, ex- and current smoking, female sex and manual work in industry. High incidence rates of asthma reported among adults during recent time may to a considerable extend be explained by an increased awareness and diagnostic activity, or altered diagnostic praxis. Different methods when measuring incidence may explain the extremely diverging incidence rates found in different studies. Register studies and retrospective studies provide in general lower incidence rates than do prospective studies. The methods used must be considered when comparing results from different studies.

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