

Asthma in late adolescence – farm childhood is protective and the prevalence increase has levelled off

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While the prevalence of and risk factors for asthma in childhood have been studied extensively, the data for late adolescence are more sparse. The aim of this study was to provide up-to-date information on the prevalence of and risk factors for asthma in the transitional period between childhood and adulthood. A secondary aim was to analyze whether the increase in asthma prevalence has levelled off. A large-scale, detailed postal questionnaire focusing on asthma and respiratory symptoms, as well as possible risk factors, was mailed to 30 000 randomly selected subjects aged 16–75 in Gothenburg and the surrounding western Sweden region. The present analyses are based on the responses from 1261 subjects aged 16–20 (560 men and 701 women). The prevalence of physician-diagnosed asthma was 9.5%, while 9.6% reported the use of asthma medicine. In the multivariate analysis, the strongest risk factors for physician-diagnosed asthma and other asthma variables were heredity for asthma and heredity for allergy, particularly if they occurred together. Growing up on a farm significantly reduced the prevalence of physician-diagnosed asthma and the likelihood of using asthma medication, OR 0.1 (95% CI 0.02–0.95). Smoking increased the risk of recurrent wheeze, long-standing cough, and sputum production. In conclusion, the prevalence of physician-diagnosed asthma and the use of asthma medication in the 16- to 20-yr age group support the notion that the increase in asthma prevalence seen between the 1950s and the 1990s has now levelled off. In line with the hygiene hypothesis, a farm childhood significantly reduced the likelihood of asthma. The adverse effects of smoking could already be seen at this young age.

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The prevalence of and the risk factors for asthma in childhood have been studied extensively (1). In contrast, the data for the transitional period from childhood to adulthood are less abundant. In late teenage and early adulthood, the viral wheeze that is common in early childhood and is sometimes present up to school age has disappeared to a large extent. Instead, asthma with allergic sensitisation dominates (2). Some subjects who have had a symptom-free period have experienced a relapse of their disease (2–4). The

extent to which environmental exposure, including the effects of exposure to tobacco smoke or occupational exposure to gas, dust, or fumes, has started to produce observable effects is, however, unclear.

The prevalence of asthma increased in most parts of the world during the second half of the 20th century (5, 6). In Sweden, the prevalence of asthma increased from 2–3% in the 1970s (7, 8) to approximately 5% in the 1980s (9, 10) and to 8–10% in the mid-1990s (11–13). However,

recent studies, including ISAAC III (1), suggest that the increase in asthma among children and teenagers is tending to level off in a number of western countries (14–16).

The present analysis is part of a large study of asthma and allergic diseases initiated in 2008 in Gothenburg and the surrounding region of West Gothia in western Sweden (17). This part of the study consists of a detailed postal questionnaire survey focusing on asthma and respiratory symptoms, as well as on possible risk factors. The aim was to provide up-to-date information on the prevalence of and risk factors for asthma in the transitional period between childhood and adulthood. We also wanted to analyze whether the increase in asthma prevalence has levelled off.

Methods

Study area and population

The study area is the region of West Gothia in western Sweden, including the city of Gothenburg. Gothenburg is the second largest city in Sweden with a population in 2007 of 494 000 and more than 700 000 when the whole metropolitan area is included. The population of the entire region was 1 547 000, corresponding to approximately one-sixth of the Swedish population.

Study population and questionnaire

In 2008, a self-administered questionnaire was mailed to 30 000 inhabitants aged 16–75 in the region of western Sweden. A sample of 15 000 subjects was randomly selected from the metropolitan area of Gothenburg. In the same way, 15 000 subjects were randomly selected from the rest of the region (17). The Swedish Population Register provided the names and addresses. This article is based on the 1261 subjects in the 16- to 20-yr age group who answered the questionnaire.

The questions were based on the Swedish OLIN study questionnaire (10) that has been used in several studies in Northern Europe (11, 13, 18) and contains questions about obstructive respiratory diseases, respiratory symptoms, rhinitis, and possible determinants of disease, such as smoking, occupation, and a family history of allergic disease. Furthermore, questions about exposure were included, together with the Swedish version of the GA2LEN questionnaire (19).

Definitions

Ever asthma: 'Have you ever had asthma?'; *Physician-diagnosed asthma:* 'Have you been

diagnosed as having asthma by a doctor?'; *Use of asthma medication:* 'Do you currently use asthma medicine (permanently or as needed)?'.

Attacks of shortness of breath: 'Do you presently have, or have you had in the last 10 yr, asthma symptoms (intermittent breathlessness or attacks of shortness of breath; the symptoms may exist simultaneously with or without a cough or wheezing)?' and 'Have you had these problems within the last year?'.

Any wheeze: 'Have you had whistling or wheezing in the chest on any occasion during the last 12 months?'; *Wheezing with breathlessness:* Yes to 'Any wheeze' and 'Have you been at all breathless when you had wheezing or whistling in the chest?'; *Wheezing apart from cold:* Yes to 'Any wheeze' and 'Have you had this wheezing or whistling in your chest when you have not had a cold?'; *Recurrent wheeze:* 'Do you usually have wheezing or whistling in your chest when you breathe?'.

Long-standing cough: 'Have you had a persistent cough during the last year?'; *Sputum production:* 'Do you usually produce phlegm when you cough or do you have phlegm in your chest which is difficult to bring up?'.

Allergic rhinitis: 'Have you ever had allergic eye or nose problems (hay fever)?'.

Family history of asthma: 'Has any of your parents or siblings ever had asthma?'.

Family history of allergy: 'Has any of your parents or siblings ever had allergic eye or nose problems (hay fever)?'.

Smokers reported smoking during the year preceding the survey. *Ex-smokers* reported having stopped smoking at least 12 months prior to the survey. *Non-smokers* reported neither smoking nor ex-smoking.

Occupational exposure: 'Have you been exposed on a large scale to dust, gases or fumes at work?'.

Raised on a farm: 'Did your family live on a farm during your first 5 yr of life?'.

Non-responders

A study of the non-responders has been reported in a separate publication (20). Regarding asthma and respiratory symptoms, no statistically significant differences between the participants and the non-responders were detected. Current smoking was, however, more common among the non-responders.

Ethical approval

The study was approved by the Ethics Committee in Gothenburg.

Analyses

Ten percent of the data were computerized twice to check the quality of the computerization. Errors amounted to 0.1–0.2% of the computerized data, with only a few exceptions. Statistical analyses were performed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Comparisons of proportions were tested with Pearson's chi-square test. A p-value of <0.05 was regarded as statistically significant. The covariates used in the analyses included age, gender, family history of asthma and/or allergy, physician-diagnosed asthma, other asthma variables, rhinitis, smoking habits, area of domicile, living on a farm during the first 5 yr of life, and occupational exposure to gas, dust, or fumes. Multiple logistic regression models were used with these independent variables as risk factors (odds ratios, OR, with 95% confidence intervals, CI) for asthma and respiratory symptoms.

Results

Participation

In the 16- to 20-yr age group, responses were obtained from 1261 subjects, 560 men and 701 women, comprising 56% of the invited women

and 43% of men ($p < 0.001$). The gender difference occurred in the 18- to 20-yr age group both in the metropolitan area of Gothenburg and in the surrounding region, while similar percentages of men and women participated in the 16- to 17-yr age group (Table 1).

Exposure variables

Smoking habits and occupational exposure. Smoking was more common in women than in men, 20.3% vs. 13.4% ($p = 0.004$). Furthermore, smoking was more common in metropolitan Gothenburg compared with the rest of western Sweden, 20.6% vs. 14.6% ($p = 0.005$). The prevalence of female smokers was particularly high in metropolitan Gothenburg, 24.3% vs. 17.1% ($p = 0.019$). The corresponding difference in smoking habits by area among men did not reach statistical significance, 15.9% vs. 11.5% ($p = 0.13$) (Table 2). Occupational exposure to gas, dust, or fumes was reported by 11.8%, similar by area, but significantly more often by men.

Domicile in childhood. Among women, 33.1% had spent the first 5 yr of their life in rural areas vs. 26.1% among men ($p = 0.02$). Of the women, 6.6% had lived on a farm for the first 5 yr of their life vs. 5.4% of men. Both a rural

Table 1. Study population and participation

	Gothenburg			West Gothia			All		
	M	F	Total	M	F	Total	M	F	Total
Invited	558	553	1111	736	691	1427	1294	1244	2538
Participated	239	309	548	321	392	713	560	701	1261
% of invited of whom	43	56	49	44	57	50	43	56	49
Aged 16–17	84	88	172	135	144	279	219	232	451
Aged 18–20	155	221	376	186	248	434	341	469	810

Table 2. Prevalence of heredity, demographic, and exposure variables. Percentages for men and women refer to percentages within gender

Variable	Gothenburg			West Gothia			All			Difference by		
	M %	F %	Total %	M %	F %	Total %	M %	F %	Total %	Age p-value	Gender p-value	Area p-value
Family history of asthma	17.6	29.1	24.1	20.6	28.1	24.7	19.3	28.5	24.4	0.456	0.001	0.532
Family history of allergy	37.7	46.9	42.9	40.5	47.2	44.2	39.3	47.1	43.6	0.863	0.017	0.171
Rural childhood	13.4	16.5	15.1	35.5	46.2	41.4	26.1	33.1	30.0	0.289	0.002	0.000
Farm childhood	2.1	1.3	1.6	7.8	10.7	9.4	5.4	6.6	6.0	0.519	0.067	0.000
Occupational exposure	13.9	9.7	11.5	16.2	8.6	12.0	15.2	9.1	11.8	0.000	0.001	0.789
Non-smoker	81.6	69.9	75.0	84.7	80.4	82.3	83.4	75.7	79.1			
Ex-smoker	1.3	5.2	3.5	3.1	2.3	2.7	2.3	3.6	3.0			
Smoker	15.9	24.3	20.6	11.5	17.1	14.6	13.4	20.3	17.2	0.000*	0.002*	0.001*

*Test for trend relating to smoking habits: non-, ex-, and current smokers.

and a farm childhood were significantly more common among the subjects living in the surrounding region compared with metropolitan Gothenburg, 41.4% vs. 15.1% and 9.4% vs. 1.6%, respectively (Table 2).

Family history of asthma and allergy. Allergy among parents or siblings was reported by 43.6%, while the corresponding figure for asthma was 24.4%. A family history of both asthma and allergy was more frequently reported by women ($p = 0.001$ and 0.017), but it was equally common by area ($p = 0.532$ and 0.171) (Table 2).

Prevalence

The prevalence of physician-diagnosed asthma was 9.5% in both metropolitan Gothenburg and the rest of western Sweden. The use of asthma medication was reported by 9.6%; 9.1% in Gothenburg vs. 10.0% (NS) in the rest of the region (Table 3). Women reported a significantly

higher use of asthma medicine, 11.7% vs. 7.0% among men ($p = 0.005$).

All respiratory symptoms, including attacks of shortness of breath, any wheeze in the last 12 months, recurrent wheeze, long-standing cough, and sputum production, were significantly more common among women (Table 3). Long-standing cough and sputum production were significantly more common in the metropolitan area of Gothenburg, while the prevalence of other symptoms more closely related to asthma was similar in both areas. The most commonly reported symptoms were sputum production, 16.4%, and any wheeze in the last 12 months, 15.9%. The latter was reported by 19.4% of women vs. 11.6% of men ($p < 0.001$). In contrast to the asthma-related and bronchitis symptoms, the prevalence of rhinitis was similar among men and women, 25.5% and 26.4% respectively (Table 3). All the symptoms were more common in the 18- to 20-yr age group, although most of them not significantly (Fig. 1).

Table 3. Prevalence of various disease variables by domicile and gender. Percentages for men and women refer to percentages within gender

Disease or symptom	Gothenburg			West Gothia			All			Difference by	
	M %	F %	Total %	M %	F %	Total %	M %	F %	Total %	Gender p-value	Area p-value
Physician-diagnosed asthma	9.2	9.7	9.5	7.8	11.0	9.5	8.4	10.4	9.5	0.247	1.000
Ever asthma	11.3	11.0	11.1	10.9	11.2	11.1	11.1	11.1	11.1	1.000	1.000
Asthma medication	6.3	11.3	9.1	7.5	12.0	10.0	7.0	11.7	9.6	0.005	0.631
Rhinitis	26.4	28.2	27.4	24.9	25.0	25.0	25.5	26.4	26.0	0.747	0.365
Eczema ever	30.1	48.2	40.3	28.0	48.5	39.3	28.9	48.4	39.7	0.000	0.728
Attacks of shortness of breath last 12 m	4.6	13.6	9.7	5.6	12.2	9.3	5.2	12.8	9.4	0.000	0.846
Any wheeze last 12 m	10.5	18.4	15.0	12.5	20.2	16.7	11.6	19.4	15.9	0.000	0.438
Wheezing with breathlessness	5.4	11.7	8.9	8.4	13.5	11.2	7.1	12.7	10.2	0.001	0.191
Wheezing without a cold	4.6	9.4	7.3	5.6	11.7	9.0	5.2	10.7	8.2	0.000	0.303
Wheezing with breathlessness apart from cold	2.1	7.1	4.9	4.7	8.4	6.7	3.6	7.8	5.9	0.002	0.188
Recurrent wheeze	3.8	8.4	6.4	3.1	5.4	4.3	3.4	6.7	5.2	0.010	0.126
Waking with tight chest last 12 m	6.3	11.3	9.1	3.1	11.0	7.4	4.5	11.1	8.2	0.000	0.300
Long-standing cough	11.7	20.1	16.4	11.8	12.5	12.2	11.8	15.8	14.0	0.042	0.034
Sputum production	15.9	23.0	19.9	11.8	15.3	13.7	13.6	18.7	16.4	0.018	0.004

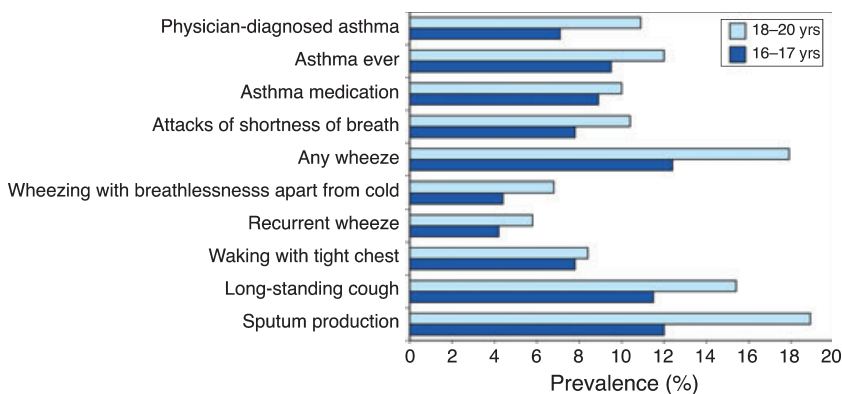


Fig. 1. Prevalence of asthma and asthma-related symptoms in the 16- to 17- and 18- to 20-yr age groups.

Risk factors

In the multivariate analysis, female gender and a family history of asthma and allergy, respectively, were significant risk factors for most of the asthma-related variables (Table 4). Heredity for either asthma or allergy doubled the risk of physician-diagnosed asthma, compared with those with no family history of asthma or allergy. Heredity for both conditions doubled the risk compared with those with only one of the factors, OR, 4.3 (95% CI 2.6–7.0) (Table 4). Similarly, heredity for either asthma or allergy doubled the risk of using asthma medication, OR 2.5 (1.1–5.6) and 2.1 (1.2–3.6), while heredity for both doubled the risk once again, OR 5.1 (3.1–8.5) (Fig. 2).

Being raised on a farm reduced the likelihood of using asthma medicine, OR 0.1 (0.02–0.95)

(Fig. 2). In line with this result, the prevalence of physician-diagnosed asthma was only 2.0% among those raised on a farm with neither a family history of asthma nor a family history of allergy, while the prevalence among those that did not grow up on a farm and had a family history of asthma or allergy, or both, was 20.8%. This result was verified by the interaction analysis. The OR for physician-diagnosed asthma was 8.2 among the subjects not raised on a farm and with a family history, compared to those raised on a farm and having none of the exposures (Fig. 3).

Smoking and occupational exposure significantly increased the risk of recurrent wheeze and long-standing cough, while being an ex-smoker was significantly associated with physician-diagnosed asthma, OR 2.6 (1.2–6.0) (Table 4).

Table 4. Effects of different independent variables on prevalence of various asthma variables. Odds ratios (OR) were calculated using multiple logistic regression analysis. Bold values indicate statistically significant ORs, $p < 0.05$ or less

Independent variables		Dependent variables					
Variables	Categories	Physician-diagnosed asthma OR (95% CI)	Attacks of shortness of breath OR (95% CI)	Any wheeze last 12 months OR (95% CI)	Recurrent wheeze OR (95% CI)	Long-standing cough OR (95% CI)	Sputum production OR (95% CI)
Age	16–17 yr	1	1	1	1	1	1
	18–20 yr	1.6 (1.01–2.5)	1.2 (0.8–1.8)	1.4 (0.97–2.0)	1.0 (0.6–1.8)	1.1 (0.7–1.5)	1.3 (0.9–1.9)
Gender	Male	1	1	1	1	1	1
	Female	1.1 (0.8–1.7)	2.7 (1.7–4.3)	1.8 (1.3–2.5)	1.9 (1.1–3.4)	1.3 (0.9–1.8)	1.3 (0.9–1.8)
Family history	No	1	1	1	1	1	1
	Asthma	1.9 (0.8–4.3)	2.8 (1.3–6.3)	1.8 (0.95–3.5)	2.7 (1.003–7.3)	1.6 (0.8–3.2)	1.6 (0.8–3.0)
	Allergy	1.9 (1.1–3.2)	2.5 (1.4–4.2)	1.5 (1.02–2.3)	1.8 (0.9–3.7)	1.1 (0.7–1.7)	1.1 (0.8–1.7)
Smoking	Both	4.3 (2.6–7.0)	4.2 (2.5–7.3)	3.2 (2.1–4.8)	3.4 (1.7–6.7)	1.7 (1.1–2.6)	1.9 (1.2–2.9)
	Non-smoker	1	1	1	1	1	1
	Ex-smoker	2.6 (1.2–6.0)	2.5 (1.04–5.8)	2.0 (0.95–4.3)	2.5 (0.9–7.1)	0.9 (0.3–2.6)	2.8 (1.3–5.8)
Occupational exposure	Smoker	0.9 (0.5–1.5)	1.5 (0.95–2.5)	1.4 (0.9–2.0)	1.6 (0.9–2.9)	3.4 (2.3–4.9)	2.8 (2.0–4.0)
	No	1	1	1	1	1	1
Farm childhood	Yes	1.0 (0.5–1.8)	1.3 (0.7–2.3)	1.7 (1.1–2.6)	2.1 (1.1–4.1)	1.6 (1.004–2.6)	1.4 (0.9–2.2)
	No	1	1	1	1	1	1
Area of domicile	West Gothia	1	1	1	1	1	1
	Gothenburg	0.9 (0.6–1.3)	0.9 (0.6–1.4)	0.8 (0.6–1.1)	1.4 (0.8–2.5)	1.3 (0.9–1.8)	1.4 (1.02–1.9)

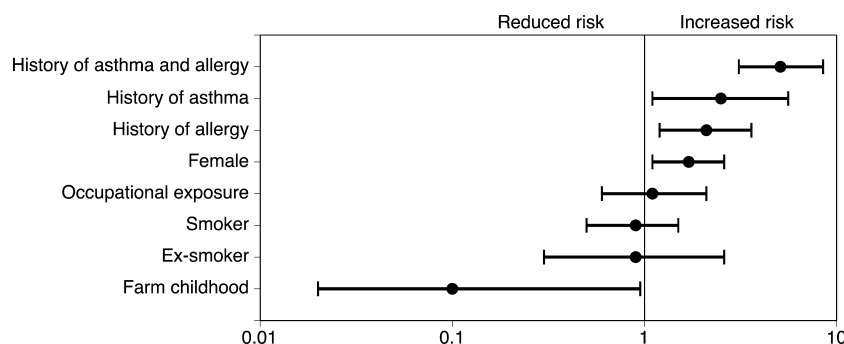


Fig. 2. Independent risk factors for asthma medication. OR and 95% CI.

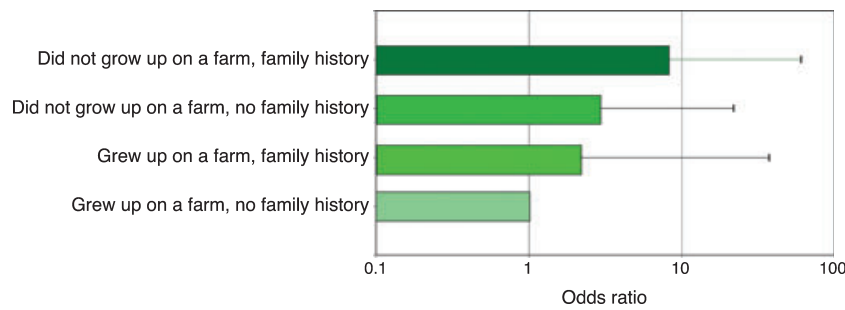


Fig. 3. Risk of physician-diagnosed asthma depending on farm childhood and family history of asthma or allergy. OR and 95% CI, with those raised on a farm and having none of the exposures as reference = 1.

When allergic rhinitis was added to the multiple logistic model as an independent variable, it yielded an OR of 3.6 (2.3–5.6) for physician-diagnosed asthma and the OR for a family history of allergy decreased considerably, while the odd ratios for the other independent variables remained stable. The OR for allergic rhinitis as a risk factor for symptoms common in asthma was also statistically significant, but to a lower degree. Similarly, the influence of a family history of allergy decreased, while the other risk factors remained stable.

Discussion

Up-to-date studies of asthma prevalence in late adolescence are scarce. Recent surveys usually pertain to early teenage (1, 21, 22). A survey from Switzerland reported a prevalence of current wheeze among 14-yr-old adolescents of 8–11% (crude) and 7–9% (adjusted) (22). The prevalence remained constant from 1992 to 2000. Moreover, other reports suggest that the increase in the prevalence of asthma in schoolchildren has now levelled off in many western countries (1, 14–16, 21). The prevalence of physician-diagnosed asthma and the use of asthma medication, 9.5% and 9.6%, in the current study are fairly well in line with the asthma prevalence in those studies. Furthermore, the current results are compatible with the asthma prevalence among young adults in Sweden in the mid-1990s, i.e., 8–10% (11–13). Taken together, these studies support the notion that the increase in asthma among adolescents has probably come to an end.

Interestingly, the prevalence of asthma was only 2% among those raised on a farm and without a family history of asthma or allergy, while the prevalence was 20% among those who were not raised on a farm and had a family history of asthma or allergy, or both. Furthermore, in line with the hygiene hypothesis, farm childhood significantly reduced the likelihood of

using asthma medicine (23, 24). These findings highlight the question of the degree to which the factors related to the urbanisation process contributed to the increase in asthma prevalence from the 1950s and onwards.

The prevalence of the use of asthma medication and of symptoms common in asthma, including attacks of shortness of breath, recurrent wheeze and long-standing cough, was higher in women than in men. This is in agreement with the well-known shift after puberty, when asthma becomes more prevalent in women than in men (2, 25).

The strong relationship between allergy and asthma is consistently shown in long-term follow-ups of asthma from childhood to adulthood (2, 3, 26). In many studies, parental asthma is a stronger risk factor for asthma than heredity for allergy (27, 28). In the present study, the two factors appeared equally strong, while heredity for both asthma and allergy further doubled the likelihood of physician-diagnosed asthma compared with having only one hereditary risk factor.

Allergic rhinitis was also a significant risk factor for physician-diagnosed asthma and symptoms common in asthma. When allergic rhinitis was added as a risk factor in the analyses, the OR for a family history of allergy decreased, while the magnitude of the other risk factors did not change more than marginally.

The higher prevalence of smoking in women is compatible with the overall higher prevalence of asthma-related variables in female subjects. Looking at areas within western Sweden, smoking was more common in the metropolitan area of Gothenburg, especially in women. Interestingly, a long-standing cough and sputum production were more common in women in Gothenburg. In spite of this, the prevalence of physician-diagnosed asthma and of the use of asthma medication was similar in Gothenburg and the surrounding region of West Gothia. It is

notable that, already at this young age, indices of the adverse effects of smoking, such as a long-standing cough and sputum production, are seen.

The fact that smoking today is more common in young women than in young men is worrying because maternal smoking during pregnancy is a risk factor for wheezing illness and bronchial hyper-responsiveness in the child. The effects in terms of increased risk of asthma and impaired lung function are long standing and may be seen even in early adulthood (29, 30). In addition, growing up with smoking parents increases the risk of the child becoming active smoker, which in turn is a risk factor for asthma (2, 29).

Not surprisingly, smoking and exposure to dust, gases, or fumes at work increased the risk of recurrent wheeze and long-standing cough. Furthermore, being an ex-smoker was already significantly associated with physician-diagnosed asthma at the age of 16–20, a common result in studies of adults (10, 13). This probably reflects a group of smokers who have given up smoking because of respiratory symptoms.

The strengths of the study are its population-based design and well-validated questions. A strength of the study as a whole is that a careful comparison has been made between participants and non-responders (20). The weaknesses of the study are those inherent in questionnaire-based studies, that is there is some uncertainty regarding the validity of answers. However, the questions were devised to minimize recall bias. In addition, dividing the population material into sub-groups weakens the statistical strength. Despite this, clear patterns were visible.

To summarize, a high prevalence of asthma and use of asthma medication of almost 10% was found among the adolescents aged 16–20. However, even if it was high, the prevalence that was found supports the notion that the increase in asthma prevalence seen between the 1950s and 1990s has now levelled off. The strongest risk factors for physician-diagnosed asthma and other asthma variables were heredity for asthma and heredity for allergy, particularly if they occurred together. If those risk factors were lacking and the subjects were raised on a farm, the prevalence of asthma was only 2%. The indices of adverse effects of smoking could already be seen at this young age.

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