

Update of prevalence of self-reported allergic rhinitis and chronic nasal symptoms among adults in Sweden

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Abstract

Background: Allergic rhinitis (AR) is the most common immunologic disease, and it renders a considerable burden on both sufferers and society. The prevalence of AR has been increasing worldwide over the past century. The aim of this study was to assess the present prevalence, risk factor patterns and comorbidity of self-reported AR and chronic nasal symptoms in different age groups in Stockholm, Sweden.

Methods: A postal questionnaire was sent on two occasions, in 2006 to a population aged 30–80 years, randomly selected 10 years previously, and in 2007 to a randomly selected sample of subjects aged 20–69 years. The response rates were 83% and 68%, respectively, and in total, 9792 subjects participated. The questionnaire included questions on self-reported AR, asthma, respiratory and nasal symptoms and possible determinants.

Results: The prevalence of self-reported AR was 28.0% (men 26.6%, women 29.1%, $P < 0.01$) similar to 10 years previously and 33.6% in ages 30–40 years. Allergic heredity [odds ratio (OR) 4.76, confidence interval (CI) 95% 4.25–5.33], physician-diagnosed asthma (OR 5.29, CI 95% 4.49–6.24) and occupational exposure to dust, gases and fumes (OR 1.49, CI 95% 1.30–1.72) were determinants for AR. Prevalence of chronic nasal congestion was 16.1% and of chronic rhinorrhea 14.1%.

Conclusions: As a basis for understanding the disease, as well as in planning and prioritising health-care resources, the study provides information about the current prevalence and determinants of self-reported AR and chronic nasal symptoms. Further, comparing with previous studies, the present study suggests that a plateau in the prevalence of AR may have been reached in Sweden.

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Key words

allergic rhinitis – chronic nasal symptoms – prevalence – risk factors – socio-economic status

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Authorship and contributorship

Jonas Eriksson conceived of the study, participated in its design, drafted the manuscript and performed the statistical analyses. Linda Ekerljung participated in the statistical analyses and revised the manuscript. Eva Rönmark revised the manuscript. Barbro Dahlén revised the manuscript. Staffan Ahlstedt revised the manuscript and contributed to its drafting. Sven-Erik Dahlén revised the manuscript. Bo Lundbäck conceived of the study, participated in its design, supervised the analyses and the drafting of the manuscript. All authors read and approved the final manuscript.

Ethics

This study has been approved by the ethics committee at the Karolinska Institute, Stockholm.

Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

Introduction

Allergic rhinitis (AR) is the most common immunologic disorder with an estimated 500 million sufferers worldwide (1). In addition, a large number of people suffer from non-allergic rhinitis (NAR) (2). Since no mortality is associated with rhinitis, it has often been trivialised. Yet the disease renders a considerable burden on both sufferers and society with impact on quality of life and daily functioning (1).

The prevalence of AR has increased markedly over the second half of the 20th century in many countries including Sweden (1, 3–5). Given the characteristic symptoms of the disease, the reported increase is likely to represent a true rise in prevalence. However, increased diagnostic activity and observance may have contributed to the increase.

AR is associated with several co-morbidities, of which asthma is of particular interest. AR is considered an important risk factor for asthma (6), and rhinitis occurs in up to 80% of patients with asthma (7). Concomitant rhinitis seems to impair asthma control (8), whereas adequate treatment of AR apparently alleviates asthma severity (9).

However, studies of chronic nasal symptoms are still very few (10–13). Further, little is known about socio-economic effects on the prevalence of AR and chronic nasal symptoms (10).

The aim of this study was to (i) estimate the prevalence of self-reported AR and chronic nasal symptoms by age, sex and socio-economic status (ii) study how these conditions covary with asthma and respiratory symptoms, and to (iii) evaluate the patterns of individual risk factors for AR, chronic nasal congestion and chronic rhinorrhea, respectively.

Materials and methods

Study population

In order to gain power in the statistical analyses, the study population consisted of two merged cohorts (Table 1). The 2006 cohort was a follow-up of a study from 1996, where 8000 randomly selected subjects in the city of Stockholm aged 20–69 years were included (14). Responders in 1996 ($N = 5754$) that could be traced in the winter of 2006 ($N = 5372$) were enrolled in the follow-up (15). The 2007 cohort was selected following the same procedure as in the 1996 cohort. Out of the 8000 subjects selected, 7845 could be traced. Thus, the total study population comprised 13 217 subjects.

Table 1. Study sample. Invited and participants in 2006, in 2007 and in total, respectively, by age and sex

Study population	20–30 years		31–40 years		41–50 years		51–60 years		61–70 years		71–80 years		All		
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Total
Invited in 2006* Participants in 2006 in % of the invited in 2006	–	–	640	773	664	711	515	592	408	481	241	347	2468	2904	5372
	–	–	456	606	518	589	438	531	367	440	225	308	2004	2474	4479
	–	–	71.3	78.4	78.0	82.8	85.0	89.7	90.0	91.5	93.4	88.8	81.2	85.2	83.4
Invited in 2007† Participants in 2007 in % of the invited in 2007	764	858	1078	985	859	859	704	650	538	550	–	–	3943	3901	7844
	369	550	633	723	508	620	505	503	436	466	–	–	2451	2862	5313
	48.3	64.1	58.7	73.4	59.1	72.2	71.7	77.4	81.0	84.7	–	–	62.2	73.4	67.7
Invited in total Participants in total in % of the invited in total	764	858	1718	1758	1523	1570	1219	1242	946	1031	241	347	6411	6806	13217
	369	550	1089	1329	1026	1209	943	1034	803	906	225	308	4455	5336	9792
	48.3	64.1	63.4	75.6	67.4	77.0	77.4	83.3	84.9	87.9	93	89	69.5	78.4	74.1

*Excluded: 84 diseased; 45 moved abroad; 8 protected personal information; 245 not traced.

†Excluded: 2 diseased; 25 moved abroad; 128 not traced.

Questionnaire

A postal self-administered questionnaire, identical for the two cohorts, was used. The questionnaire, which has been previously described (16), was developed from a widely used questionnaire in the Nordic countries, (17) based mainly on the British Medical Research Council questionnaire (18) and the Tucson questionnaire and contained questions on asthma, rhinitis, chronic bronchitis and use of asthma medications (16). In addition, questions on chronic nasal congestion and chronic rhinorrhea were added for the version used in 2006–2007. These questions are highly comparable with questions recently included in the ARIA (Allergic Rhinitis and its Impact on Asthma) (1) and GA²LEN (Global Allergy and Asthma European Network) surveys. Questions about smoking habits, occupation, early life exposures and family history of disease were also included.

Definitions

Self-reported AR: 'Have you ever had allergic eye or nose problems (hay fever)'; *chronic nasal congestion*: 'Do you have nasal block more or less constantly'; *chronic rhinorrhea*: 'Do you have a runny nose more or less constantly'; *allergic heredity*: 'Has any of your parents or siblings ever had allergic eye or nose problems (hay fever)'; *physician-diagnosed asthma*: 'Have you been diagnosed as having asthma by a doctor'; *Recurrent wheeze*: 'Do you usually have wheezing or whistling in your chest when breathing'; *occupational exposure*: 'Have you been substantially exposed to dust, gases or fumes at work'; *raised on farm*: 'Did your family live on a farm during your first 5 years of life'.

Smoking was divided into three categories. *Current smokers* were defined as those currently smoking or having stopped smoking during the last year. Subjects who had stopped smoking more than 12 months prior to the study were considered *ex-smokers*, whereas *non-smokers* were defined as those that were neither smokers nor ex-smokers.

Analyses

Chi-squared test was used for bivariate comparisons, and one-way analysis of variance was used in testing for trends. Multiple logistic regression analysis was performed in order to assess the simultaneous influence of possible determinants of self-reported AR, chronic nasal congestion and chronic rhinorrhea, respectively. The independent variables include sex, age, family history of allergic disease, physician-diagnosed asthma,

socio-economic status, smoking, occupational exposure to dust, gases and fumes, season of birth and being raised on a farm during the first 5 years of life. A P value < 0.05 and a 95% confidence interval (CI) were considered significant. All statistical analyses were performed using the Statistical Package for the Social Sciences (version 16.0; SPSS Inc, Chicago, IL, USA).

Results

Demographics

Of the total study population, 9792 subjects (74.1%) participated. In the 2006 cohort, 4479 (83.4%) subjects took part in the study, while 5313 (67.7%) subjects participated in the 2007 cohort. The mean age of the 2006 cohort was 52.4 years, and that of the 2007 cohort was 43.8 years (P value < 0.01). Other background variables, including gender composition and socio-economic status, were similar between the groups (details are given in Supporting Information Table S1 in the online depository). A significantly higher response rate was found among women than among men (78.4% vs 69.5%, $P < 0.001$). The response rate was lowest among the youngest men (48%) and increased with increasing age among both men and women up to 93% and 89%, respectively (Table 1).

Prevalence of rhinitis

Self-reported AR was reported by 28.0%, chronic nasal congestion by 16.1% and chronic rhinorrhea by 14.1% (Table 2). The prevalence by age was similar in the 2006 cohort as in the 2007 cohort. Self-reported AR was slightly but significantly more common among women than among men (29.1% vs 26.6%, $P < 0.01$), whereas chronic nasal congestion was significantly more common among men (17.1% vs 15.2%, $P = 0.02$). No significant difference by sex was found for chronic rhinorrhea.

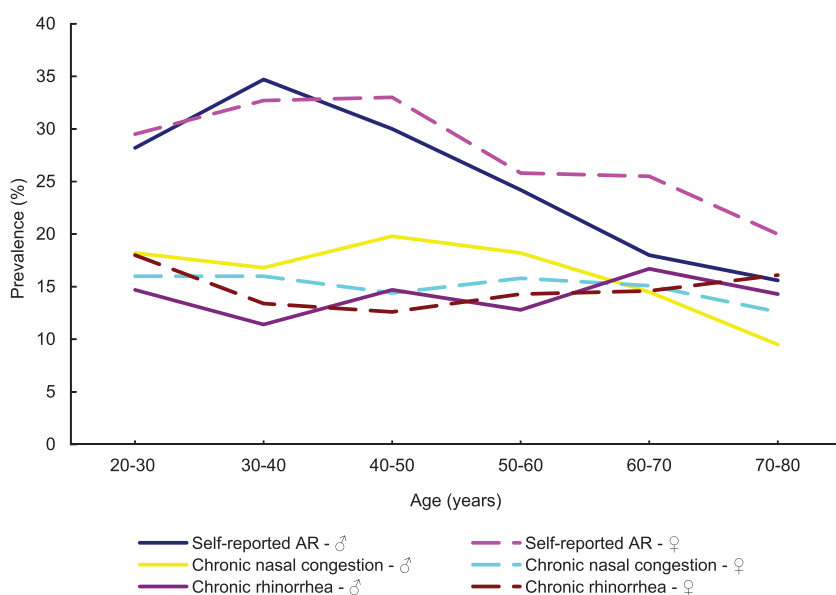
The highest prevalence was found in ages 30–40 years (33.6%), while the lowest prevalence was found in ages 70–80 years (18.1%). When stratified by sex, the prevalence of self-reported AR was similar for men and women before 60 years of age, while there was a considerably higher prevalence among women above 60 years of age (Fig. 1).

The prevalence of chronic nasal congestion was stable before 60 years of age, and decreased subsequently. Chronic rhinorrhea was reported quite evenly by age, with the highest prevalence in ages 20–30 years (16.7%).

Among subjects with self-reported AR, 37% also had chronic nasal symptoms (i.e. chronic nasal congestion

Table 2. Prevalence of self-reported allergic rhinitis, chronic nasal congestion and chronic rhinorrhea by age and sex

Symptom or condition	20–30 years (%)	31–40 years (%)	41–50 years (%)	51–60 years (%)	61–70 years (%)	71–80 years (%)	Men (%)	Women (%)	Total (%)	Difference by	
										Age (P value)	Sex (P value)
Self-reported allergic rhinitis	28.9	33.6	31.6	25.1	22.0	18.1	26.6	29.1	28.0	<0.001	0.008
Chronic nasal congestion	16.9	16.4	16.9	16.9	14.8	11.3	17.1	15.2	16.1	0.016	0.015
Chronic rhinorrhea	16.7	12.5	13.5	13.6	15.6	15.3	13.9	14.2	14.1	0.012	0.641

**Figure 1.** Prevalence of self-reported AR, chronic nasal congestion and chronic rhinorrhea by age and gender. AR, allergic rhinitis.

or chronic rhinorrhea), and among subjects with chronic nasal symptoms, 48% had concomitant self-reported AR. Isolated chronic nasal congestion was reported by 4.4%, while 3.3% reported chronic rhinorrhea alone. Moreover, 5.2% reported self-reported AR as well as both chronic nasal symptoms (Fig. 2).

Rhinitis and respiratory symptoms

All of the respiratory symptoms presented in Table 3 were significantly more prevalent among subjects with self-reported AR, chronic nasal congestion and chronic rhinorrhea, respectively, than in the total study population. Physician-diagnosed asthma was most prevalent, 22.3%, among subjects with self-reported AR, while the prevalence among those with chronic rhinorrhea was 18.8%. However, the pattern was inverted for *any wheeze last 12 months* and *recurrent wheeze* as well, which proved to be most prevalent among subjects with chronic rhinorrhea and least prevalent

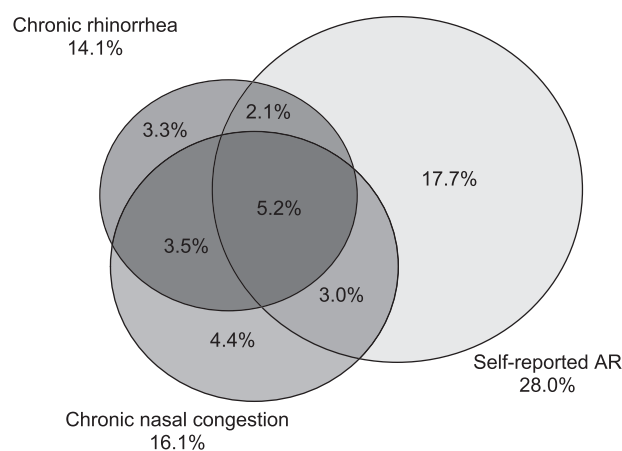
**Figure 2.** Venn diagram of the prevalence of self-reported AR, chronic nasal congestion and chronic rhinorrhea describing the overlap between the three variables. AR, allergic rhinitis.

Table 3. Prevalence of physician-diagnosed asthma and respiratory symptoms among subjects reporting self-reported allergic rhinitis, chronic nasal congestion and chronic rhinorrhea

Symptom or condition	Self-reported allergic rhinitis (%)	Chronic nasal congestion (%)	Chronic rhinorrhea (%)
Physician-diagnosed asthma	22.3	19.2	18.8
Any wheeze last 12 months	24.6	25.7	26.2
Recurrent wheeze	13.1	18.8	19.1
Long-standing cough	18.2	26.7	28.2
Chronic productive cough	8.7	14.9	17.0

Prevalence: physician-diagnosed asthma 9.6%; any wheeze last 12 months 11.2%; recurrent wheeze 7.3%; long-standing cough 12.7%; chronic productive cough 5.9%.

All above-listed associations were statistically significant (P value < 0.001).

among those with self-reported AR. Further, the prevalence of both *long-standing cough* and *chronic productive cough* was high among subjects with chronic rhinorrhea (28.2% and 17.0%) and lower among those with self-reported AR (18.2% and 8.7%).

Socio-economic status

Self-reported AR was reported almost equally over the different socio-economic groups, ranging from 28.0% to 29.8%, with exception for manual workers in industry, where the prevalence was 22.6%.

Prevalence of chronic nasal congestion and chronic rhinorrhea showed a different pattern, both with the lowest prevalence among professionals and the highest

among manual workers in service. Significant differences by sex were found among manual workers in industry, where both chronic nasal congestion and chronic rhinorrhea were markedly more prevalent among men (Table 4).

Multivariate relationships

The distribution of the variables used in the multivariate analyses is shown in Table 5. When calculating risks by use of multiple logistic regression analysis, somewhat different risk factor patterns were found for self-reported AR, chronic nasal congestion and chronic rhinorrhea, respectively (Table 6).

Significant risk factors for self-reported AR were allergic heredity [odds ratio (OR) 4.76], physician-

Table 4. Prevalence of self-reported allergic rhinitis, chronic nasal congestion and chronic rhinorrhea in men and women by socio-economic status

Symptom or condition	Manual workers in industry*	Manual workers in service†	Assistant non-manual workers‡	Professionals§	Difference (P value)
Self-reported allergic rhinitis					
Men	21.4%	27.2%	28.6%	27.2%	0.017
Women	28.7%	31.5%	28.8%	28.7%	0.363
Total	22.6%	29.8%	28.7%	28.0%	0.004
Difference	0.090	0.057	0.960	0.294	
Chronic nasal congestion					
Men	20.7%	24.1%	16.3%	14.1%	<0.001
Women	14.8%	19.9%	17.5%	12.2%	<0.001
Total	19.8%	21.6%	17.0%	13.0%	<0.001
Difference	0.160	0.040	0.508	0.064	
Chronic rhinorrhea					
Men	19.1%	19.8%	12.7%	10.8%	<0.001
Women	11.3%	18.3%	16.3%	11.2%	<0.001
Total	17.8%	18.9%	14.9%	11.0%	<0.001
Difference	0.046	0.423	0.026	0.734	

* N = 708.

† N = 1793.

‡ N = 2057.

§ N = 4357 including high- and middle-level civil servants.

Table 5. Distribution of background variables among subjects with self-reported allergic rhinitis, chronic nasal congestion and chronic rhinorrhea

Variables	Categories		Self-reported allergic rhinitis	Chronic nasal congestion	Chronic rhinorrhea	Total population
Mean age ($\pm$ SD)		years	45.5 ($\pm$ 13.5)***	46.9 ($\pm$ 13.5)**	48.2 ($\pm$ 14.6)	47.7 ($\pm$ 14.1)
Sex	Women (reference: men)	%	56.6**	51.7*	55.1	54.5
Allergic heredity	Yes (reference: no)	%	51.4***	35.8***	36.2***	26.4
Physician-diagnosed asthma	Yes (reference: no)	%	22.3***	19.2***	18.8***	9.6
Smoking	Non-smoker	%	55.4**	45.2***	45.3***	52.7
	Ex-smoker	%	26.7	27.4	26.7	26.9
	Current smoker	%	17.9***	27.4***	27.9***	20.5
Socio-economic status	Professionals	%	48.7	39.3***	38.4***	48.9
	Assistant non-manual employees	%	23.6	24.2	24.5	23.1
	Manual workers in service	%	21.3	26.8***	27.0***	20.1
	Manual workers in industry	%	6.4***	9.7**	10.1**	7.9
Occupational exposure to dust, gases and fumes	Yes (reference: no)	%	21.9***	28.6***	30.2***	17.7
Raised on a farm before 5 years of age	Yes (reference: no)	%	7.8	10.1**	10.9***	8.2

P* value < 0.05; *P* value < 0.01; ****P* value < 0.001. All *P* values were calculated comparing subjects with the specific condition (e.g. self-reported allergic rhinitis) with those without.

SD, standard deviation.

diagnosed asthma (OR 5.29), age groups between 30 and 70 years compared with ages 70–80 years (OR 1.35–1.80), and occupational exposure to dust, gases or fumes (OR 1.49). Significant negative association with self-reported AR was found for current smoking (OR 0.76) and manual work in industry (OR 0.70).

Significant risk factors for chronic nasal congestion were allergic heredity (OR 1.55), physician-diagnosed asthma (OR 2.47), ex-smoking (OR 1.21), current smoking (OR 1.53), all age groups compared with ages 70–80 years (OR 1.49–1.74), manual work in service (OR 1.46), being an assistant non-manual employee (OR 1.37), occupational exposure to dust, gases or fumes (OR 1.77), and being raised on a farm before 5 years of age (OR 1.37). Female gender was significantly negatively associated (OR 0.85).

Significant risk factors for chronic rhinorrhea were allergic heredity (OR 1.60), physician-diagnosed asthma (OR 2.32), current smoking (OR 1.57), manual work in service (OR 1.39), being assistant non-manual employee (OR 1.28), occupational exposure to dust, gases or fumes (OR 1.94) and being raised on a farm before 5 years of age (OR 1.35).

Also controlled for was season of birth, which showed no significant association to any of the depen-

dent variables. When physician-diagnosed asthma was excluded from the analyses, the ORs of the remaining variables proved to be close to constant (they differ in the second decimal), with exception for allergic heredity, which became stronger in association to self-reported AR (OR 5.02), chronic nasal congestion (OR 1.67) and chronic rhinorrhea (OR 1.75), respectively.

Discussion

We have found the prevalence of self-reported AR in Stockholm to be 28%. The prevalence of AR is high in comparison with other Swedish and Western European studies (1, 19, 20). Population studies conducted in various Swedish areas in 1992–2000 have reported the prevalence of AR among adults to be 19%–27% (4, 12, 21–23). Since 1996, the prevalence of self-reported AR in Stockholm only increased by 1% unit (27%–28%) (4). Thus, a plateau in AR prevalence may have been reached. Indeed, such a plateau has recently been shown for both children and teenagers in several areas in Western Europe by The International Study of Asthma and Allergies in Childhood (ISAAC) studies (24). Further, in a Swedish study from 1992, the peak prevalence of AR was found in ages 20–29 years (22),

Table 6. Risk factors for self-reported allergic rhinitis, chronic nasal congestion and chronic rhinorrhea by multiple logistic regression analysis

Independent variables		Dependent variables		
Variables	Categories	Self-reported allergic rhinitis OR (95% CI)	Chronic nasal congestion OR (95% CI)	Chronic rhinorrhea OR (95% CI)
Sex	Women (reference: men)	0.93 (0.83–1.04)	0.85 (0.75–0.96)	0.99 (0.87–1.14)
Allergic heredity	Yes (reference: no)	4.76 (4.25–5.33)	1.55 (1.36–1.77)	1.60 (1.39–1.84)
Physician-diagnosed asthma	Yes (reference: no)	5.29 (4.49–6.24)	2.47 (2.09–2.91)	2.32 (1.95–2.77)
Smoking	Non-smoker	1	1	1
	Ex-smoker	0.96 (0.85–1.09)	1.21 (1.05–1.40)	1.13 (0.97–1.31)
	Current smoker	0.76 (0.65–0.88)	1.53 (1.31–1.78)	1.57 (1.34–1.85)
Age	70–80 years	1	1	1
	60–70 years	1.35 (1.03–1.76)	1.49 (1.10–2.03)	1.06 (0.81–1.40)
	50–60 years	1.41 (1.08–1.84)	1.72 (1.27–2.32)	0.87 (0.66–1.15)
	40–50 years	1.80 (1.39–2.33)	1.72 (1.28–2.33)	0.84 (0.64–1.11)
	30–40 years	1.74 (1.34–2.25)	1.65 (1.22–2.23)	0.77 (0.58–1.02)
	20–30 years	1.28 (0.92–1.78)	1.74 (1.21–2.53)	0.99 (0.70–1.41)
Socio-economic status	Professionals	1	1	1
	Assistant non-manual employees	1.09 (0.95–1.24)	1.37 (1.18–1.60)	1.28 (1.09–1.50)
	Manual workers in service	0.97 (0.83–1.12)	1.46 (1.24–1.71)	1.39 (1.17–1.64)
	Manual workers in industry	0.70 (0.55–0.87)	1.19 (0.95–1.51)	1.19 (0.94–1.52)
Occupational exposure to dust, gases and fumes	Yes (reference: no)	1.49 (1.30–1.72)	1.77 (1.53–2.05)	1.94 (1.67–2.26)
Raised on a farm before 5 years of age	Yes (reference: no)	1.09 (0.89–1.32)	1.37 (1.12–1.68)	1.35 (1.09–1.66)

OR, odds ratio; CI, confidence interval. Statistically significant associations are presented in bold figures.

whereas we report the highest prevalence in ages 30–40 years among men and in ages 40–50 years among women. Our findings thus indicate that the incidence of AR in Sweden is no longer increasing. However, the prevalence of the disease in other areas is still very high and increasing, causing major illness and disability (1).

We found a gender difference in the prevalence of self-reported AR. The prevalence was slightly but significantly higher among women than among men ($P < 0.01$), in line with previous results (22, 23). In addition, the prevalence of self-reported AR varied considerably more by age among men than among women (Fig. 1).

The prevalence of chronic nasal congestion and chronic rhinorrhea was 16% and 14%, respectively. Though various studies have measured the prevalence of nasal symptoms, hardly any examined persistent symptoms specifically. In a Swedish study from 1992, nasal congestion was reported by 21% and nasal discharge by 17% (11). In Nottingham in 1998, nasal congestion was reported by 17% and rhinorrhea by 20% (10). However, these two studies included both recurrent and permanent symptoms, making comparisons uncertain.

The questions on self-reported AR and chronic nasal symptoms are not mutually exclusive. On the contrary, we found that they overlapped considerably. About a third of subjects with self-reported AR reported also chronic nasal symptoms, while the remainder reported no chronic nasal symptoms. Thus, subjects with self-reported AR are likely to represent both subjects with perennial and seasonal rhinitis. The questions on chronic nasal symptoms are likely to represent a wide spectrum of nasal conditions, including persistent AR, chronic rhinosinusitis with or without polyps, anatomical deformities and a number of phenotypes of NAR (1, 25).

We found that 48% of subjects with chronic nasal symptoms also report AR. This finding indicates that a substantial portion of rhinitis is of a non-allergic phenotype, which is in agreement with previous studies (12, 26).

Since the questionnaire of the current study was developed before the ARIA workshop in 2001 (1), questions on intermittent and persistent rhinitis were not included. Rather, previous definitions were conserved in order to facilitate over-time and inter-study comparisons.

The present study strongly supports a close relationship between AR and asthma (27). Subjects with self-reported AR had a prevalence of physician-diagnosed asthma of 22.3%, which is five times higher than found in subjects without AR. Other European studies have reported similar proportions of asthma in rhinitis (7, 9, 28). However, in subjects with AR to animals and mites, the proportion with asthma has been found to be more than 50% (29). We found a high prevalence of physician-diagnosed asthma also in subjects with chronic nasal congestion and chronic rhinorrhea, which is in accordance with a study from Leynaert *et al.* (7) and indicates that the correlation between asthma and rhinitis may be independent of the presence of allergy.

We found a lower prevalence of self-reported AR among manual workers in industry than in other socio-economic classes, supporting an association of increased prevalence of AR to relative affluence (27, 30). Interestingly, in women, one could find no such association. However, the reason for this gender difference can only be speculated upon.

Chronic nasal congestion and chronic rhinorrhea were both markedly more prevalent in lower socio-economic classes. The prevalence of occupational rhinitis is likely to be higher among manual workers, since exposure is a major risk factor for that condition (31).

Using a multivariate model, we found the strongest risk factors for prevalent self-reported AR to be allergic heredity and physician-diagnosed asthma, both with ORs of around 5. The importance of allergic heredity for the occurrence of AR has been reported by others (4, 32). The perception of asthma as a risk factor for rhinitis is not unproblematic, given the close relationship between the two diseases (33). Hence, the result should primarily be interpreted as a confirmation of the strong association between the diseases, even when controlled by several other influential factors. Our model proved to be very stable. Indeed, the risk factor pattern remained unchanged even when physician-diagnosed asthma was excluded from the analyses.

Further, we found an age-dependent risk of self-reported AR, most pronounced in ages 40–50 years (OR 1.8). Age was reported as a risk factor for AR in a Swedish study from 1996 (4), yet with greatest risk in ages 20–39 years. Apparently contradictory, manual work in industry was associated with a lower risk of self-reported AR, while occupational exposure to dust, gases or fumes was associated with a greater risk of the disease. However, subjects reporting occupational exposure also reported allergic heredity to a significantly higher extent ($P < 0.05$). Since no supposable relation exists between these two factors, the increased

risk of self-reported AR associated with occupational exposure may have been biased by a higher recall rate among subjects with AR.

Chronic nasal symptoms had a different risk factor pattern than self-reported AR. In accordance with the weaker allergic component of chronic nasal symptoms, the strength of association to physician-diagnosed asthma and allergic heredity, respectively, was clearly less prominent. Further, current smoking proved to be a significant risk for chronic nasal symptoms.

This population-based cohort study conducted in the capital of Sweden benefits from its large-scale and good response rate (74%). The large number of participants was obtained by merging two populations that received the same questionnaire using the same method. The 2006 population had a higher mean age since it was selected in 1996. However, other background and outcome variables were in essence equally distributed in the 2006 and the 2007 cohorts. Furthermore, the questionnaire used has been widely used in the Nordic countries, simplifying inter-study comparisons. According to a recent study of non-response using the same questionnaire, no difference was found in the prevalence of self-reported AR between responders and non-responders (34). Several studies assessed the validity of the questionnaire on physician-diagnosed asthma, proving the questionnaire to have excellent specificity in Sweden (35, 36).

A limitation of this study is the lack of objective measurements, such as function testing, skin prick tests and Immunoglobulin E-measurement. However, a recent study in West Sweden using the same questionnaire found that approximately 85% of the subjects with self-reported AR were sensitised to any common airborne allergen. The multiple logistic regression analysis is a powerful instrument to examine the strength of association of individual variables. Yet since our analyses are based on cross-sectional data, the associations do not necessarily represent causality. Apart from causality, associations could also be due to a consequence of the condition itself or to a parallel phenomenon. The presented factors should thus be considered as possible determinants that need further evaluation in longitudinal analyses.

In conclusion, we found the prevalence of self-reported AR in a large-scale cross-sectional population-based sample in Stockholm to be 28%, with the peak prevalence in ages 30–40 years among men and 40–50 years among women. Our findings indicate that a plateau of AR may have been reached in the adult population in Stockholm. Furthermore, physician-diagnosed asthma and allergic heredity were found to be strong determinants for self-reported AR.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Distribution of background and main outcome variables in the 2006 and 2007 cohorts.

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Supplementary table 1. Distribution of background and main outcome variables in the 2006 and 2007 cohorts.

	2006 population N = 4479	2007 population N = 5313	p-value
Mean age (years)	52.4	43.8	<0.001
Female gender (%)	55.2	53.9	0.18
Manual workers in industry (%)	8.3	7.6	0.29
Manual workers in service (%)	19.4	20.8	0.09
Assistant non-manual employees (%)	24.2	22.0	0.01
Professionals (%)	48.2	49.5	0.20
Self-reported allergic rhinitis (%)	27.9	28.0	0.87
Chronic nasal congestion (%)	16.0	16.1	0.83
Chronic rhinorrhea (%)	14.8	13.5	0.08
Current smoking (%)	18.9	18.8	0.90
Physician-diagnosed asthma (%)	9.9	9.3	0.32