

ORIGINAL ARTICLE

Incidence and Prevalence of Asthma and Allergic Rhinitis: A Cohort Study of Finnish Adolescents

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ABSTRACT

Only limited data are available about the incidence of asthma and allergic rhinitis based on prospective longitudinal studies throughout childhood into adult life. The main purpose of the study was to estimate the incidence rate of asthma and allergic rhinitis from birth to early adulthood. We also estimated the prevalences of these diseases at 16, 22, and 32 years of age. The data were drawn from a follow-up survey of a Finnish urban age cohort (1967 birth cohort, N=2269) from age 16 to age 32 years. All data were based on self-report. The prevalence of asthma from age 16 to age 32 years changed from 3.0% to 5.0% (males from 3.3% to 4.9%; females from 2.7% to 5.1%); and that of allergic rhinitis from 17.5% to 26.0% (males from 18.7% to 27.8%; females 16.2% to 24.5%), respectively. The overall incidence rate of asthma was approximately 2.1 new cases per 1000 person-years (95% CI=1.6–2.8). There was a tendency for boys to have a higher incidence rate of asthma than girls in childhood before 16 years of age: gender difference was reversed from period 17 to 22 years of age. In early adulthood (23–32 years), incidence rates were equal in both sexes. The incidence rate for allergic rhinitis in males was 13.4 per 1000 person-years (95% CI=11.8–14.8), slightly greater than in females, 11.4 (95% CI=10.1–12.8). Among both

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genders, the highest incidence rate of allergic rhinitis was between 17 and 22 years. Our study adds to the limited knowledge on the incidence rates of asthma and allergic rhinitis.

Key Words: Asthma; Allergic rhinitis; Incidence; Prevalence; Longitudinal studies; Adolescence.

INTRODUCTION

Several studies have shown that the prevalence of allergic diseases and asthma has increased during recent decades in Finland (1–8) and elsewhere [e.g., Refs. (9–14)], but the explanations for this rise are still unclear. Changes in medical practice and increased awareness of allergic diseases have been suggested as well as exposure to environmental airway irritants (e.g., air pollution and tobacco smoke), genetic factors, and increases in those subpopulations (urbanization, increasing education, smaller family size, etc.) where allergic disease is common (7,15). It has also been presented (16) that the increase of asthma and wheezing illness may be due to information bias, and there is a lack of objective measurement in population-based samples to support claims for an increase in asthma.

Relatively little is known about the natural course of asthma from childhood to adult age. It has been presented that the prognosis of childhood asthma is highly variable, and the course of asthma from childhood to adulthood include phases of remission, relapse, and improvement of disease (17–19). It has also been shown that asthma is more prevalent among boys than girls during childhood, whereas in adulthood, asthma is more frequent among women (20,21). Furthermore, it has been found that there is decreasing severity of asthma from adolescence continuing in adulthood among the males but not in the females (18).

Allergic rhinitis symptoms have been suggested to begin typically in childhood and adolescence and to continue into adulthood. It has been presented that, in general, allergic rhinitis symptoms slowly improve and skin-test reactivity tends to wane with increasing age. In addition, a significant trend for symptom improvement has been found with younger age of onset of allergic rhinitis (22).

Most of the studies have estimated the prevalence rather than the incidence rate of allergic diseases. The prevalence and incidence are both influenced by changes in the determinants of the diseases and diagnostic practice, but prevalence is further influenced by factors affecting the duration of disease, such as time of the diagnosis and determinants of survival.

Therefore, incidence rate is a better measure of occurrence, when the interest lies in etiology of the disease.

The main purpose of the present cohort study was to estimate the incidence rate of asthma and allergic rhinitis retrospectively from birth until age 16 years and prospectively from age 16 to 32 years of age. We also estimated the prevalences of these diseases at 16, 22, and 32 years of age.

METHODS

Subjects

The original study population included all ninth grade pupils attending secondary school in the spring of 1983 in Tampere (1967 birth cohort, N=2269), an industrial and university town in southern Finland with 166,000 inhabitants. These persons were studied at the ages of 16, 22, and 32. In the first phase, in 1983, 2194 pupils (96.7%), with a mean (SD) age of 15.9 (0.3) years completed a self-administered questionnaire during school hours. In the second phase, questionnaires were mailed to the same study cohort in the spring of 1989 when they were about 22 years old. From the original study population, four had died, 18 could not be identified because of inappropriate completion or missing identification numbers, and the addresses of 33 could not be found (17 of them were known to have moved abroad). Thus, the follow-up cohort included 2139 persons (97%), and the response rate was 77.3% (N=1656). In the third phase, in 1999, postal questionnaires were sent to the same study population at the age of 32. The cohort included 2091 persons who had participated in the first phase of the study in 1983 and who could be reached. From the original study population, 22 had died, 5 were institutionalized, 14 could not be identified because of inappropriate completion or missing identification numbers, and the addresses of 62 were not available. The response rate at age 32 was 70.3% (n=1471).

A comparison of the participants and non-participants showed that the participants in the follow-up surveys included more of those who reported allergic rhinitis at age 16. This was true especially for males. No



differences were found in the prevalence of asthma at any point of the follow-up.

Measures and Statistical Analyses

In each of the three phases, the subjects were asked with identical questions whether they had any of seven common chronic illnesses including asthma, allergic rhinitis, other allergies, allergic skin conditions, other skin conditions, migraine, and diabetes mellitus. Open-ended questions were used to collect information about other illnesses. The question was "Do you have any of the following chronic illnesses?" Questions required either yes or no answers.

The prevalence was calculated by dividing the number of subjects with the disease of interest by the size of total study population at the given point in time. The cumulative incidence representing the risk of developing the disease of interest was the number of new cases divided by the number of disease-free subjects at the beginning of the time period of interest. The confidence intervals for prevalence and cumulative incidence were based on binomial distribution. The incidence rate was calculated by dividing the number of new cases by the amount of person-time free of disease experienced by the cohort, which produced the new cases. The exact 95% confidence intervals (95% CI), based on Poisson distribution, were calculated by using Newton's method (Stata Statistical Software, ci procedure). The incidence and prevalence analyses were based on different sets of subjects. The study population for incidence analysis consisted of all subjects who answered all three questionnaires ($n=1262$), whereas prevalence analyses were based on all subjects responding to the questionnaire of the year for which prevalence was calculated (1983, 1989, 1999).

RESULTS

Prevalence of Asthma and Allergic Rhinitis at 16, 22, and 32 Years of Age

The prevalence of self-reported asthma from age 16 to age 32 years changed from 3.0% to 5.0% (males from 3.3% to 4.9%; females from 2.7% to 5.1%); and that of allergic rhinitis from 17.5% to 26.0% (males from 18.7% to 27.8%; females 16.2% to 24.5%), respectively. There was a tendency that during adolescence, asthma was more prevalent among boys than girls, whereas in early adulthood and adulthood, asthma was more frequent among females. The risk of allergic rhinitis was significantly higher among males than that of females at the age of 22 (Table 1).

Incidence of Asthma and Allergic Rhinitis from Childhood to Early Adulthood

Table 2 shows the estimated total and age-specific incidence rates and cumulative incidences for self-reported asthma. The overall incidence rates for the 32 years were similar in males and females, approximately 2.1 new cases per 1000 person-years (95% CI=1.6–2.8). In males, the peak of incidence rate was between 23 and 32 years of age, whereas in females it was between 17 and 22 years of age. There was a tendency for boys to have a higher incidence rate of asthma in childhood before 16 years of age: gender difference was reversed in late adolescence at 17–22 years of age. In early adulthood, between 23 and 32 years of age, incidence rates were equal in males and females. The incidence rate for allergic rhinitis in males was 13.2 per

Table 1. The prevalence of asthma and allergic rhinitis at 16, 22, and 32 years of age by gender.

Age	Males			Females			Total		
	%	(n/N)	95% CI	%	(n/N)	95% CI	%	(n/N)	95% CI
AGE 16									
Asthma	3.3	(37/1116)	2.3–4.3	2.7	(29/1071)	1.7–3.7	3.0	(66/2187)	2.3–3.7
Allergic rhinitis	18.7	(209/1115)	16.4–21.0	16.2	(173/1069)	14.0–18.4	17.5	(382/2184)	15.9–19.1
AGE 22									
Asthma	2.5	(19/759)	1.4–3.6	3.5	(31/883)	2.3–4.7	3.0	(50/1642)	2.2–3.9
Allergic rhinitis	23.7	(180/759)	20.7–26.8	17.1	(151/881)	14.7–19.6 ^a	20.2	(331/1640)	18.2–22.1
AGE 32									
Asthma	4.9	(31/636)	3.2–6.6	5.1	(40/787)	3.5–6.6	5.0	(71/1423)	3.9–6.1
Allergic rhinitis	27.8	(177/636)	24.3–31.3	24.5	(193/789)	21.5–27.5	26.0	(370/1425)	23.7–28.2

^aDifferences between males and females with allergic rhinitis $\chi^2=10.9$, $df=1$, $p<0.001$.

Table 2. The incidence of asthma in the Tampere Cohort, 1967–1999.

Age period	Males					Females						
	New cases	Person-years at risk	IR ^a	95% CI	Cul ^b	95% CI	New cases	Person-years at risk	IR ^a	95% CI	Cul ^b	95% CI
0–16	37	17,560	2.1	1.5–2.9	0.021	0.014–0.289	29	16,904	1.7	1.2–2.5	0.017	0.011–0.024
17–22	6	4,374	1.4	0.5–3.0	0.035	0.013–0.075	16	5,118	3.1	1.8–5.1	0.048	0.028–0.077
23–32	13	4,935	2.6	1.4–4.5	0.061	0.033–0.102	17	6,595	2.6	1.5–4.1	0.074	0.044–0.116
0–32	56	26,461	2.1	1.6–2.8	0.061	0.046–0.078	62	28,901	2.2	1.7–2.8	0.074	0.057–0.094

^aNumber of new cases per 1000 person-years.

^bRisk of developing asthma during the age period of interest.

Table 3. The incidence of allergic rhinitis in the Tampere Cohort, 1967–1999.

Age period	Males					Females						
	New case	Person-years at risk	IR ^a	95% CI	Cul ^b	95% CI	New cases	Person-years at risk	IR ^a	95% CI	Cul ^b	95% CI
0–16	209	16,168	12.9	11.2–14.8	0.129	0.113–0.146	173	15,720	11.0	9.4–12.8	0.110	0.095–0.126
17–22	62	3,396	18.3	14.0–23.4	0.312	0.248–0.381	55	4,233	13.0	9.8–16.9	0.240	0.186–0.300
23–32	38	3,410	11.1	7.9–15.3	0.423	0.319–0.531	63	5,015	12.6	9.7–16.1	0.366	0.294–0.443
0–32	309	23,361	13.2	11.8–14.8	0.423	0.387–0.460	291	25,478	11.4	10.1–12.8	0.366	0.322–0.401

^aNumber of new cases per 1000 person-years.

^bRisk of developing asthma during the age period of interest.

1000 person-years (95% CI=11.8–14.8), slightly greater than in females, 11.7 (95% CI=10.1–12.8). Among both genders, the highest incidence rate of allergic rhinitis was between 17 and 22 years (Table 3).

DISCUSSION

The main aim of this birth cohort study was to investigate the incidence of asthma and allergic rhinitis from birth to early adulthood. This was conducted partly retrospectively and partly prospectively. We also estimated the prevalences of these diseases at three points in time between 16 and 32 years of age. Only limited data are available about the incidence of asthma based on prospective longitudinal studies throughout childhood into adult life. Even less is known about the incidence of allergic rhinitis; we identified only one previous study covering the age range from childhood to adulthood from Tecumseh, Michigan, published in 1974 (23).

The results showed that the overall incidence rate of asthma for the 32 years was approximately 2.1 new cases per 1000 person-years. In early adulthood, between 23 and 32 years of age, incidence rate was 2.6 per 1000 person-years, which is within the range of figures obtained in recent studies among adult population in Finland (2) and similar to the results from elsewhere (24–27). Our incidence rates of asthma among children until age 16 (males 2.1 per 1000 person-years; females 1.7 per 1000 person-years) were also consistent with the rates found among Finnish children and adolescents at corresponding points of time (28) but lower than those obtained among Swedish (29,30) and British (20) adolescents. In our study, the self-reported incidence rates of allergic rhinitis among boys until age 16 were 12.9 and among girls 11.0 new cases per 1000 person-years. Norrman et al. (30) found similar rates in their study of Swedish adolescents.

Reported prevalence rates for asthma vary considerably from one country to another at around 1%–20%. The worldwide pattern of prevalence rates for allergic rhinitis is similar to asthma, but the rates are approximately 2–3 times higher (31). In our study, the prevalence rate of self-reported asthma was 4.9% among males and 5.1% among females at the age of 32. The corresponding figures of allergic rhinitis were 27.8% among males and 24.5% among females. Our asthma prevalences fall into range obtained in recent Finnish studies. In the study of Kotaniemi et al. (32), the physician-diagnosed prevalence rate of asthma was 3.8% among males and 4.7% among females aged 30–

39. Pallasaho and coauthors (33) found slightly higher figures: physician-diagnosed asthma was 5.2% among males and 6.9% among females aged 20–44. The prevalence of doctor-diagnosed asthma was 3.5% among subjects aged 25–44 in the study of Hedman et al. (3). Their prevalence rate of allergic rhinitis was 37.3%, which is higher than ours. The study of Hedman and coauthors was conducted during the peak months for seasonal allergic rhinitis, which may have some effect on the prevalence. The interpretation and comparison of prevalence and incidence data for asthma and allergic rhinitis between studies is, however, difficult because of the different age composition of the cohorts, different methods of classification, and diagnosis of disease and, possibly, by increased public and physician awareness of both conditions (31).

Epidemiological data on asthma prevalence, morbidity, and severity seem to point to a sex difference that varies with age in the risk of having asthma (34). Boys have higher incidence and prevalence rates than girls in childhood, whereas around the puberty, the male disadvantage disappears (20,34–37) and women's risk of developing asthma increases higher than that in males (20,34,36,37). Similar trends from childhood to late adolescence, although not statistically significant, were also found in our study. In our study, however, between 23 and 32 years of age, incidence rates were equal in males and females as in the Swedish study by Toren and Hermansson (38). Sex difference reversal during puberty has been linked to airway size, which is on average smaller in boys than in girls in infancy, but becomes larger in boys during and after puberty (34). Furthermore, hormonal factors (34), as well as experience of different exposure to certain allergens and irritants from the puberty have been suggested as possible explanations (20).

The study has several limitations. All data were based on self-report: asthma and allergic diagnosis could not be verified objectively. The information related to diagnoses was, however, provided in each of the three phases by identical questions. The response rates were reasonably high, but the dropout analyses showed that the participants in the follow-up surveys included more of those who had reported allergic rhinitis at age 16. This was true especially for males and may have had an effect on higher prevalence rates among them. Our study included one age cohort that does not enable differentiating between effects of age and period. Despite these limitations, we think that our study adds to the existing literature because few data are available about the incidences of asthma and allergic rhinitis based on prospective longitudinal studies throughout childhood into adult life.

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