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Time trends of the prevalence of asthma and allergic disease in Austrian children

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After a substantial increase in the prevalence of atopic disease in Europe, recent studies indicate that a plateau has been reached. However, variation across countries and age groups exists. We studied the prevalence and time trends of asthma and allergic disease among schoolchildren in Austria, a country with traditionally low rates of asthma, hay fever, and eczema. As part of the International Study of Asthma and Allergies in Childhood (ISAAC), symptoms and physician diagnoses of asthma and allergic disease of 13,399 Austrian children aged 6–7 yr and 1516 children aged 12–14 yr were surveyed between 1995 and 1997. A similar survey was conducted between 2001 and 2003. Among children aged 6–7 yr, significant increases were seen in the prevalence of physician-diagnosed asthma (+16%; $p = 0.013$), hay fever (+22%; $p < 0.001$), and eczema (+37%; $p < 0.001$) between 1995 and 2003. These changes were paralleled by an increase in the prevalence of symptoms typical for hay fever (itchy eyes and runny nose), but not by an increase in wheeze. Among children aged 12–14 yr, the lifetime prevalence of diagnosed asthma increased by 32%, of hay fever by 19%, and of eczema by 28% (all, $p < 0.001$). These changes were paralleled by increases in the prevalence of wheezing as documented by both questions before and after a video showing wheezing children but not by symptoms typical for hay fever such as itchy eyes and runny nose. In conclusion, in Austria, contrary to other European countries, the prevalence of asthma and allergic disease increased among schoolchildren. Additional studies are needed to continue monitoring the dynamics of the prevalence of asthma and allergic disease in Austria and to explore trends in their risk factors.

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The prevalence of asthma, atopic eczema, and allergic rhinitis (hay fever) has risen substantially over the past decades (1), making atopic disease a significant public health burden worldwide. In the United States, the prevalence of childhood asthma doubled from 3.6% in 1980 to 7.5% in 1995 (2). Large geographical variation, with higher prevalence rates of asthma in westernized countries (e.g., the United Kingdom, Australia, and New Zealand) and much lower prevalence rates in Eastern Europe, India, China, other Asian countries, and Africa (3) led to the speculation that environmental or lifestyle factors contribute significantly to the etiology of the disease. Today, some of the risk factors most consistently implicated in the development of some (asthma) but not all atopic diseases include obesity (1, 4), cockroach infestation (5), and air pollution including indoor pollutants like environmental tobacco smoke (ETS) (6–8). Allergic sensitization, e.g., having lived with a pet at any time, on the other hand, has been associated inversely with current asthma in some (9) but not all studies (10–12), and results have generally been more consistent with dog ownership (13).

Initial time trends reported increases in the prevalence of asthma and allergies among schoolchildren in several countries [e.g., Poland (14), Germany (15, 16), Spain (17, 18), Hong Kong (19), Estonia (20), Morocco (21), and

China (22)]. More recently, several studies reported a plateau or decline in these prevalence rates. A reduction in prevalence of asthma symptoms was seen, for example, in Belgium (23), Great Britain (24), Singapore (25), Hong Kong (26), Brazil (27), Italy (28), and Switzerland in 5- to 7-yr-old children during four consecutive time periods (29). Moreover, German (30) and Swiss (31) studies with immunoglobulin E (IgE) measurements as a marker for atopic sensation also reported no current increase in asthma prevalence or allergic disease. The largest study to date evaluating world wide time trends of atopic disease symptoms, using data collected in 37 countries including parts of the data presented in this paper, shows mixed results for allergy symptoms throughout western Europe (32). However, few studies have evaluated time trends of doctors' diagnoses of atopic disease and little is known about time trends of potential risk factors such as number of siblings, ETS, or breast feeding.

We sought to study the prevalence and time trends for asthma and allergic disease and potential risk factors in children and adolescents in Austria (a western European country with traditionally low rates of atopic disease) using a two-timed, questionnaire-based assessment of physician diagnoses and symptoms of atopic disease. We expected to find a stable or declining prevalence of asthma and allergic disease in Austria as in other European countries.

Methods

Study population

As part of the International Study of Asthma and Allergies in Childhood (ISAAC), we surveyed symptoms and physician diagnoses of asthma and allergic disease in children in Austria aged 6–7 yr (grades 1 and 2) at two different time points. The first survey was conducted between 1995 and 1997 [ISAAC Phase I (33)], and the second was conducted among children in the same age group between November 2001 and November 2003 [ISAAC Phase III (34)]. The initial survey (1995–1997) included all schools in Upper Austria (one of Austria's nine federal states; total population of 1,392,965 in 2004). The results of this study have already been published (35). For reasons of time and cost, the second survey (2001–2003) was conducted only among schools of seven of 18 districts selected to represent a random distribution of Upper Austria. The seven districts surveyed between 2001 and 2003 comprised Eferding, Freistadt, Grieskirchen, Linz-Land, Perg, Urfahr-Umgebung, and Wels-Land. To improve comparability, we restricted both initial and subsequent survey to these seven districts. All schools of these districts were invited to participate. Overall participation rates for the two surveys (1995–1997 and 2001–2003) were 95.9% and 93.1%, respectively. In total, 13,399 and 12,784 children aged 6–7 yr participated in the 1995–1997 and 2001–2003 surveys, respectively. In one of the seven districts (Urfahr-Umgebung), adolescents aged 12–14 yr (grades 7 and 8) were also simultaneously surveyed (initially between November 1995 and February 1996 and then between January and March 2003). The district Urfahr Umgebung comprises 27 small towns representative of Upper Austria. In 1996, 1516 completed questionnaires were available for 1642 invited students aged 12–14 yr (1636 students participated, for a participation rate of 99.6%; 1516 of them returned a valid questionnaire). In 2003, 1601 (95.7%) of 1673 students of 15 schools in Urfahr Umgebung who attended grades 7 and 8 participated and 1443 returned complete questionnaires. The study was approved by the respective Offices of Public Health and was conducted in collaboration with the districts' school inspectors.

Survey instrument

For the surveys, we used an internationally standardized and validated questionnaire (36, 37) to which we added a few simple demographic questions. A physician's diagnosis of any of the three forms of atopic disease queried (asthma, hay fever, and eczema) was defined as a positive response to the questions 'Has a doctor ever diagnosed one of the following diseases in your child? Asthma (yes/no), hay fever (yes/no), and eczema (yes/no).' In addition to several questions regarding severity and recentness of related symptoms, we assessed several lifestyle variables and demographics. With the exception of a few additions such as body mass index, which we assessed only on the second survey, key questions remained identical between the two evaluations. Parents of the 6- to 7-yr-old children answered the survey on behalf of their children, whereas the 12- to 14-yr-old children, with approval of their legal guardians, filled in the questionnaires themselves. Furthermore, both traditional and video questionnaires, showing the signs and symptoms of asthma, were administered at school to the adolescents. The two methods have previously been validated and, in general, responses to the video questionnaire gave a

lower prevalence than those to the written questionnaire, with closely correlated responses overall (38).

Previous validation studies have also established that, whereas the ISAAC criteria questions for atopic eczema did not perform particularly well [positive-predictive value (PPV), 48.8%; negative-predictive value (NPV), 57%] (39), the responses, especially for asthma (40), of parents and adolescents themselves to the questionnaire are quite comparable (41).

Statistical analysis

All data were entered manually and analyzed in the Department of Epidemiology of the Centre of Public Health at Medical University of Vienna between 1995 and 2004. A random sample (10%) of questionnaires was entered twice, and the consistency was 100%. Based on parental questionnaires (for the children aged 6–7 yr) and questionnaire data for the children aged 12–14 yr, the prevalence of asthma, hay fever, and eczema was calculated for both cross-sectional surveys. The chi-square distribution was used to test the significance of the difference in prevalence from the two time periods (1995–1997 and 2001–2003). All p-values are two-sided, and p values of ≤ 0.05 were considered statistically significant. All statistical analyses were done with the SAS 8.2 statistical package (SAS Institute, Cary, NC, USA).

Results

Children aged 6–7 yr

A total of 14,210 schoolchildren aged 6–7 yr from the seven selected districts in Upper Austria were invited to participate in 1995, and 13,731 children from these districts were invited in 2001; 13,399 and 12,784 children returned and completed the questionnaires, with response rates of 95.9% and 93.1%, respectively. The gender ratio and mean age for the two assessments were similar (Table 1). The proportion of children with a family history of atopic disease (father and/or mother with a history of asthma, hay fever, or eczema) increased significantly ($p < 0.001$) from 19.9% in 1995–1997 to 25.6% in 2001–2003. We also observed significant increases in the proportion of children, who were breast fed, from 77.1% in 1995–1997 to 82.6% in 2001–2003 ($p < 0.001$) and in children who had regular contact with animals, either at home or through friends, farming, or hobbies, as well as a decline in exposure to environmental tobacco smoke from 36.7% to 24.4% ($p < 0.001$).

Table 1. Characteristics of 6- to 7-year-old and 12- to 14-yr-old children in Upper Austria, comparing two different time periods (1993–1995 and 2001–2003)

Variable	ISAAC Phase I (1995–1997)	ISAAC Phase III (2001–2003)	p for difference
Age 6–7 yr			
n	13,399	12,784	
Mean (s.d.) age (years)	7.2 (0.8)	7.2 (0.8)	1.0
Gender (female, %)	51.6	51.3	0.63
Austrian nationality (%)	92.9	93.5	0.05
Parental education high (%)*	31.7	37.8	<0.001
Number of siblings ≥2 (%)	N/A§	37.1	
Parental allergic history†(%)	19.9	25.6	<0.001
Tobacco smoke exposure at home (%)‡	36.7	24.2	<0.001
Mother smoked during pregnancy (%)	5.8	5.4	0.16
Breast-feeding (%)	77.1	82.6	<0.001
Regular contact with animals (%)¶	56.9	62.4	<0.001
Age 12–14 yr			
n	1516	1443	
Mean (s.d.) age (years)	13.2 (3.9)	13.3 (2.4)	0.66
Gender (female, %)	51.7	51.1	0.73
Austrian nationality (%)	97.8	99.3	<0.001
Parental education high (%)*	N/A§	N/A§	
Number of siblings ≥2 (%)	51.6	52.7	0.53
Parental allergic history† (%)	14.6	16.6	0.12
Tobacco smoke exposure at home (%)‡	39.6	30.4	<0.001
Mother smoked during pregnancy (%)	N/A§	N/A§	
Breast-feeding (%)	N/A	N/A	
Regular contact with animals (%)¶	74.4	74.9	0.75

*High parental education is defined as either mother or father graduated from high school or had a university education.
†Family history (father or mother) of asthma, eczema, or hay fever.
‡Environmental tobacco smoke defined as any passive smoke in child's home.
§N/A indicates that data have not been collected.
¶Regular contact with animals was queried regarding dogs, cats, hamsters/guinea pigs, mice, rabbits, birds, as well as 'other' (to be specified by participant).

We observed a modest increase in the prevalence of asthma and allergic disease among children in grades 1 and 2 (Table 2). Specifically, the prevalence of reported physician-diagnosed asthma increased from 4.4% during the first assessment to 5.1% during the second (2001–2003, p for difference = 0.013). Similarly, the prevalence of hay fever changed from 3.7% in 1995–1997 to 4.5% in 2001–2003 ($p < 0.001$). We also observed a statistically significant increase in the prevalence of eczema (from 10.1% to 13.8%; $p < 0.001$). These changes were paralleled by increases in the prevalence of symptoms typical for hay fever (itchy eyes and

Table 2. Prevalence of asthma, hay fever, and eczema among Austrian children 6–7 yr old and living in seven districts of Upper Austria: 1995–2003

	ISAAC Phase I	ISAAC Phase III	p for difference*
n	13,399	12,784	
Diagnoses (%)			
Asthma	4.4	5.1	0.013
Hay fever	3.7	4.5	<0.001
Eczema	10.1	13.8	<0.001
Symptoms (%)			
Wheeze ever	19.4	19.1	<0.001
Wheeze in past 12 months†	43.5	39.6	0.24
Itchy eyes & runny nose in past 12 months	4.4	5.6	<0.001

*p value from chi-square test.
†Among children who reported having ever wheezed.

Table 3. Prevalence of asthma, hay fever, and eczema among Austrian children 12–14 yr old and living in Urfahr Umgebung (Upper Austria): 1995–2003

	ISAAC Phase I	ISAAC Phase III	p for difference*
n	1516	1443	
Diagnoses (%)			
Asthma	5.4	7.1	0.05
Hay fever	14.5	17.3	0.04
Eczema	6.3	12.1	<0.001
Symptoms (%)			
Wheeze ever	19.7	28.0	<0.001
Wheeze in past 12 months†	11.7	15.0	0.01
Wheeze ever (video)	10.8	17.3	<0.001
Wheeze in past 12 months (video)†	6.5	8.5	0.04
Itchy eyes runny nose in past 12 months	9.2	9.6	0.87

*p value from chi-square test.
†Among children who reported having ever wheezed.

runny nose in the past 12 months) but not by an increase in wheeze (Table 2).

Children aged 12–14 yr

Like in the younger age group (6–7 yr old), we also noted a significant decline in the proportion of older children (aged 12–14) exposed to ETS in their homes in 2001–2003 ($p < 0.001$), with ETS generally lower among the younger children. In the older children, unlike in the younger children, no statistically significant difference was found in family history of atopic disease in the two time periods (14.6% vs. 16.6%, p for difference = 0.14). Other baseline characteristics were comparable between the two time periods among children aged 12–14 yr.

Among children aged 12–14 yr, we also observed a modest increase in prevalence of asthma and allergic disease (Table 3). Specifically, the lifetime prevalence of diagnosed asthma increased from 5.4% during the first assessment (1993) to 7.1% during the second assessment (2003, p for difference = 0.05). Similarly, the prevalence of hay fever changed from 14.5% to 17.3% ($p < 0.001$). In addition, we observed a statistically significant increase in the prevalence of eczema (from 11.7% to 15.0%; $p < 0.001$). Consistent with these findings were parallel increases in the prevalence of wheezing, as documented by answers to questions both before and after a video showing wheezing children but not by symptoms typical for hay fever such as itchy eyes and runny nose (Table 3).

Discussion

In Upper Austria, in contrast to several other European countries, we observed a statistically significant increase in the prevalence of childhood asthma, allergic rhinitis, and eczema among schoolchildren between 1995 and 2003.

While the prevalence of asthma and allergies has risen substantially over the past decades in several European countries (9, 14–18, 20), more recently, it has appeared to have reached a plateau or even to have started to decline (23, 24, 28–31). Prevalence rates for asthma and allergic disease have traditionally been lower in Austria (< 5%) as compared with those in other European countries (42), but no previous study has evaluated asthma and allergic disease diagnosis trends over time in Austria. Data in this paper are not directly comparable with those presented earlier (32), because Asher et al. (32) included only a subset of the children from Upper Austrian in our study; moreover, unlike the study of Asher et al. which concentrated on symptoms of allergic disease, our primary focus was on physician diagnosis of allergic disease.

Among the risk factors most consistently implicated in the development of asthma and allergic disease are obesity (1) and exposure to outdoor and indoor pollutants, including ETS (6, 7). In addition, other changes in lifestyle including diet, physical activity, and exposure to infection or inflammation, may contribute to changes in prevalence. Our two surveys were conducted in the same geographic region, comprising both rural and urban areas that are representative of Austria and for which, to our knowledge, air pollution levels have not changed substantially between 1995 and 2003, likely minimizing a major influence of changes in

particulate matter or other forms of outdoor air pollutants as a risk factor contributing to the observed increase in childhood asthma. Also, according to our data, exposure of children to ETS appears to be declining in Upper Austria. However, it is possible that the observed increase in family history of atopic disease and in body mass index among Austrians (43–45), as recently noted, particularly among schoolchildren (46), may be contributing to the observed increase in childhood asthma. Moreover, smoking habits among adolescents in Austria (47) also warrant exploration and should be taken into account in future studies. A parallel increase in atopy among parents in our study, particularly those of the younger children, in conjunction with our observation of larger baseline prevalence and increase of asthma among the older children could be indicative of a cohort effect, suggesting that some environmental change occurred but at an earlier date, thus affecting the prevalence of asthma in the older age-groups more so than in the younger age groups.

Our findings of an increase in the prevalence of eczema in Upper Austria are consistent with prevalence data from Carynthia, another federal district of Austria (48, 49). Austria's uniform health care system with 100% coverage ensures equal access for all children, eliminating major concerns regarding confounding by socioeconomic status and diagnostic bias. However, an incentive system has newly been introduced in Austria, allowing parents of children with eczema to request financial government aid. Thus, parents may have been more likely to report this diagnosis subsequent to the introduction of this incentive system, which may have contributed to the observed increase in eczema prevalence in our study, and these results must therefore be viewed with caution. While the most consistent increase over time that we observed in our study pertained to doctors' diagnosis of asthma in the younger age groups and hay fever in the older age group, time trends in the prevalence of typical symptoms for these diseases only partially followed the same pattern in our analyses. Diagnostic bias provides one likely explanation for these discrepant time trends, whereas underreporting of symptoms, particularly among the older age-group for hay fever (a video was shown to them for asthma symptoms) and for asthma reported by the parents of children of the younger age groups (who were not shown a video), could serve as an alternate explanation.

The strengths of our study include the use of a standardized survey instrument, large sample size, and close to 100% participation rates of districts in Austria that are uniform with regard to ethnicity and air pollution/fine particle pollution over the periods investigated. The seven districts in Upper Austria represent a random sample of both rural and urban areas and are well comparable with other areas in Upper Austria.

In summary, we observed a statistically significant, although modest, increase in the prevalence of asthma, hay fever, and eczema among schoolchildren in Austria. Future studies such as birth cohorts are needed to examine risk and protective factors and to continue monitoring the dynamics of the prevalence of asthma and allergic disease in Austria.

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