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Increasing prevalence of allergic rhinitis symptoms in an adult Danish population

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There is evidence that the prevalence of respiratory allergy is increasing. This is mainly based on studies in children and young adults. The aim of the study was to compare the prevalences of self-reported symptoms of respiratory allergy among Danish adults in two surveys 8 years apart. Identical questionnaires were mailed to two random general population samples in 1989 and 1997. The response rates were 86.1% ($n=3603$) and 86.4% ($n=817$), respectively. The sampling frame and sampling method were identical in both surveys. The changes in the prevalences of symptoms were expressed by sex- and age-adjusted odds ratios comparing 1997 to 1989. We found a significant increase in the prevalence of seasonal rhinitis symptoms (OR=1.6, 95% CI 1.4–1.9), rhinitis symptoms on exposure to pollen (OR=1.6, 95% CI 1.4–1.9), rhinitis symptoms on exposure to furry animals (odds ratio 1.6, 95% CI 1.3–2.0), rhinitis symptoms on exposure to house dust (OR=1.3, 95% CI 1.1–1.6), and breathlessness on exposure to pollen (OR=1.5, 95% CI 1.0–2.0). The observed increases were independent of sex and age. The questionnaire was validated in relation to allergen skin test reactivity in a subgroup of the responders to the 1989 survey. When the estimated associations between symptoms and skin test reactivity were considered, the results suggested an increase in allergy to pollen and animal dander. In conclusion, we found evidence of increased prevalence of allergic rhinitis symptoms associated with skin test reactivity.

Respiratory allergy defined as an IgE-mediated immune response to inhalant allergens may lead to both allergic rhinitis and asthma. There is evidence that the prevalence of respiratory allergy is increasing in children (1–4) and young

adults (5–8), whereas the evidence for a corresponding increase in adults is limited. However, the reported increases in disease prevalence in children and young adults over recent decades should now be apparent in increased disease prevalence in adults. This paper describes a repeated cross-sectional survey of respiratory allergy in Danish adults. The aim of the study was to investigate time trends in the prevalence of symptoms of respiratory allergy over an 8-year period.

Material and methods

First survey

The first survey was conducted in 1989 and has been described previously (9). A short questionnaire on respiratory symptoms was sent to 8000 subjects, aged 15–69 years, comprising a nonstratified random sample of the population living in the western part of Copenhagen County (urban area). Citizenship (Danish) and birthplace (Denmark) further restricted the sample. The questionnaires were mailed in November 1989 and followed – if necessary – by two reminders. The response rate was 87.5% ($n=6998$; of this total, 3603 subjects were 15–41-year-olds).

In order to assess the association between the reported symptoms and allergen skin test reactivity, a randomly selected subgroup of the responders to the first survey was skin prick tested (9). A total of 793 were invited for allergen skin prick test (SPT), and 599 (75.5%) were examined. Phazet (Pharmacia Diagnostics AB, Sweden) was used for the skin prick tests. The panel comprised 10 allergens (birch, grass, mugwort, horse, dog, cat, two mites [*Dermatophagoides pteronyssinus* and *D. farinae*], and two molds [*Cladosporium* and *Alternaria*], and a negative and a positive control were included. A positive SPT was defined as a mean wheal diameter of at least 3 mm. The associations between the reported symptoms and skin test reactivity to one or more of 10 allergens, to one or more of the allergens in the pollen group (birch, grass, or mugwort), to one or more of the allergens in the dander group (horse, cat, or dog), and to one or more of the allergens in the mite group (*D. pteronyssinus* or *D. farinae*) were calculated (Table 1).

Second survey

The second survey was conducted in 1997. A questionnaire identical to the one used in the first survey was sent to 946

subjects, aged 15–41 years, comprising another random sample, with restrictions identical to those in the first survey. In May 1997, the questionnaires were mailed to the 15–22-year-old subjects ($n=246$), and in September–November 1997, the questionnaires were mailed to the 23–41-year-old subjects ($n=700$). The questionnaire was followed – if necessary – by two reminders. The subjects who did not respond were contacted by telephone in order to obtain their answers.

Statistical analysis

All data were analyzed with the Statistical Products and Service Solutions package (SPSS) for windows (Release 7.5). Only 15–41-year-old subjects from the first survey were included in the analysis. The difference in mean age between the two surveys was examined by independent-samples *t*-test. The changes in the prevalences of symptoms were expressed by odds ratios comparing 1997 to 1989. The odds ratios were adjusted for the effects of sex and age group in a logistic regression model, including an interaction term between sex and age group. The test for homogeneity of the odds ratios in the different age groups was done by testing for interaction between survey and age group in a logistic regression model using a likelihood-ratio test.

Results

A total of 817 questionnaires were completed (response rate 86.4%), 715 by self-completion and 102 by telephone interview. The prevalences of symptoms in 1989 and 1997 and odds ratios comparing 1997 to 1989 are presented in Table 2. The frequency of missing answers ranged between 0.0% and 1.4%.

The prevalences of rhinitis symptoms on exposure to pollen, animal dander, and house dust increased significantly (questions b., c., and d.). In addition, the prevalence of rhinitis symptoms during the summer months increased significantly (question a.). The results were less clear regarding lower airway symptoms on exposure to allergens. The questionnaire comprised three questions on breathlessness on exposure to allergens, of which only breathlessness on exposure to pollen increased significantly (question f.). The observed increases were independent of sex and age group.

The response rates in the two oldest age groups were significantly different from the first survey, tending toward a relatively older population in the 1997 survey (Table 3). The

Table 1. Associations between reported symptoms and SPT reactivity, expressed by sex- and age-adjusted odds ratios (95% CI), were assessed in subgroup of responders to 1989 survey (n=312, age 15–41 years)

Question	At least one positive SPT of 10 allergens	Pollen (one positive SPT of birch, grass, or mugwort)	Animal dander (one positive SPT of cat, dog, or horse)	Dust mites (one positive SPT of <i>D. pteronyssinus</i> or <i>D. farinae</i>)
a. Itchy or stuffy nose or sneezing during summer months	2.9 (1.7–5.0)*	3.1 (1.7–5.7)*	4.2 (1.9–9.2)*	2.1 (1.1–4.1)*
b. Itchy or stuffy nose or sneezing when near grass, trees, or flowers	3.9 (2.1–7.3)*	6.3 (3.2–12.3)*	5.7 (2.5–13.0)*	2.0 (0.9–4.2)
c. Itchy or stuffy nose or sneezing when near furry animals	3.1 (1.5–6.6)*	2.2 (0.6–7.9)	10.4 (4.2–26.1)*	5.6 (2.5–12.3)*
d. Itchy or stuffy nose or sneezing when cleaning rooms or making beds, or when in bed	1.1 (0.6–2.1)	0.6 (0.3–1.4)	1.0 (0.4–2.8)	1.9 (0.9–4.1)
e. Shortness of breath when at rest at any time in last 12 months	1.8 (0.9–3.6)	1.5 (0.7–3.3)	2.3 (0.9–6.2)	3.3 (1.5–7.2)*
f. Shortness of breath when near grass, trees, or flowers	3.5 (0.9–13.6)	6.7 (1.7–26.9)*	10.1 (2.2–46.3)*	2.8 (0.7–11.9)
g. Shortness of breath when near furry animals	2.7 (0.6–13.2)	4.9 (1.0–24.3)*	15.7 (2.8–88.5)*	7.8 (1.6–38.4)*
h. Shortness of breath when cleaning rooms or making beds, or when in bed	1.7 (0.4–6.4)	1.0 (0.2–5.3)	1.0 (0.1–9.0)	4.3 (1.1–17.0)*
i. Shortness of breath when hurrying on level ground or walking up slight hill	1.2 (0.7–2.2)	1.2 (0.6–2.3)	0.7 (0.2–2.0)	1.0 (0.5–2.3)
j. Shortness of breath when walking with other people of your own age on level ground	1.6 (0.4–6.3)	1.7 (0.4–7.4)	1.4 (0.2–12.8)	2.5 (0.6–11.0)
k. Having to stop for breath when walking at your own pace on level ground	**	9.1 (0.7–111.3)	**	13.4 (1.1–164.0)*

* $P < 0.05$.
 **Odds ratio not calculated (empty cell in cross-tabulation).

mean age difference was 1.4 years (0.8–2.0, 95 % CI). The sex distribution did not differ significantly in 1997 from the first survey (1989: male 48.5%, female 51.2% – 1997: male 47.0%, female 53.0%).

Telephone interviews were used in the second survey to maintain a high response rate and to estimate possible

selection bias. Two subjects refused to answer the questions when contacted by telephone. Comparison of the responses obtained by telephone interview with those obtained by self-completed questionnaire (Table 4) showed that rhinitis symptoms were less frequently reported by telephone interview, unlike lower airway symptoms. The results of

Table 2. Prevalences of reported symptoms in 1989 and 1997. Changes in prevalences of symptoms are expressed by sex- and age-adjusted odds ratios comparing 1997 to 1989

Question	1989 (n=3603) Yes (%)	1997 (n=817) Yes (%)	Odds ratio (95% CI)
a. Itchy or stuffy nose or sneezing during summer months	22.3	31.5	1.61 (1.36–1.90)*
b. Itchy or stuffy nose or sneezing when near grass, trees, or flowers	16.9	24.8	1.61 (1.35–1.94)*
c. Itchy or stuffy nose or sneezing when near furry animals	10.2	15.2	1.59 (1.27–1.98)*
d. Itchy or stuffy nose or sneezing when cleaning rooms or making beds, or when in bed	19.0	24.1	1.33 (1.11–1.60)*
e. Shortness of breath when at rest at any time in last 12 months	14.4	14.4	0.96 (0.77–1.19)
f. Shortness of breath when near grass, trees, or flowers	3.9	5.8	1.46 (1.04–2.06)*
g. Shortness of breath when near furry animals	3.6	4.8	1.33 (0.92–1.92)
h. Shortness of breath when cleaning rooms or making beds, or when in bed	4.7	5.9	1.19 (0.85–1.65)
i. Shortness of breath when hurrying on level ground or walking up slight hill	23.9	23.9	0.95 (0.79–1.13)
j. Shortness of breath when walking with other people of your own age on level ground	4.4	6.0	1.28 (0.92–1.79)
k. Having to stop for breath when walking at your own pace on level ground	2.4	3.3	1.33 (0.86–2.07)

* $P < 0.05$.

Table 3. Distribution of responders by age groups in 1989 and 1997

Age group (years)	1989		1997	
	Responders	Response rate	Responders	Response rate
15–22	1055 (29.3%)	83.3% (1055/1266)	200 (24.5%)	81.3% (200/246)
23–31	1232 (34.2%)	87.6% (1232/1407)	238 (29.1%)	82.9% (238/287)*
32–41	1316 (36.5%)	87.0% (1316/1512)	379 (46.4%)	91.8% (379/413)*
Total	3603 (100%)	86.1% (3603/4185)	817 (100%)	86.4% (817/946)

*Response rate significantly different from 1989 ($P < 0.05$, chi-square test).

the telephone interviews were included in the analysis, thereby adjusting the prevalences slightly.

Discussion

This study indicates a remarkable increase in self-reported allergic rhinitis symptoms over the last 8 years, suggesting an increase in respiratory allergy.

The questionnaire comprised questions on respiratory symptoms on exposure to three groups of allergens, i.e., pollen, animal dander, and house-dust mites. Sensitizations to these allergens are common in the studied population (10). The questionnaire was validated in relation to skin test reactivity in the first survey, and several questions proved to be associated with this (Table 1). Hence, the results suggest an increase in allergy to pollen, since we observed an increase in seasonal rhinitis symptoms, rhinitis symptoms on exposure to pollen, and breathlessness on exposure to pollen. These three questions were all associated with a positive SPT to pollen. Furthermore, rhinitis symptoms on

exposure to furry animals increased, suggesting an increase in allergy to animal dander. Caution should be exercised when interpreting the observed increase in rhinitis symptoms on exposure to house dust because of the poor association between these symptoms and a positive SPT. It is notable that mainly symptoms associated with skin test reactivity have increased, indicating that the observed increases did not seem to be part of a general increase in the reporting of health symptoms.

Repeated surveys of health and morbidity conducted in Danish adults have reported increases in the 1-year prevalences of self-reported hay fever (6.5% vs 10.3%), perennial allergic rhinitis (4.0% vs 6.7%), and asthma (3.2% vs 5.0%) from 1987 to 1994 (11). The prevalences increased in all age groups. These increases in self-reported diagnoses of hay fever and perennial allergic rhinitis were slightly higher than the increases in self-reported symptoms observed in this study. Prevalence rates of symptoms were expected to be higher than prevalence rates of diagnoses, since symptoms may represent both allergic and nonallergic disease.

Surveys in adults have reported a higher prevalence of allergic rhinitis in Hamburg (former West Germany) than Erfurt (former East Germany) (12). It is hypothesized that prevalence rates were similar before Germany was divided and diverged after the division. The biggest difference in the prevalence of allergic rhinitis between Hamburg and Erfurt was found for the youngest birth cohort. Therefore, it is assumed that the increasing prevalence of allergic rhinitis in Western Europe is caused by a cohort effect, i.e., an increase in the prevalence of disease among young adults. Furthermore, this cohort effect may be linked to changes in lifestyle factors in Western Europe during the 1950s and 1960s. These factors are believed to have an influence very early in life, thereby affecting only individuals born after this period. In this study, we did not find a cohort effect, since the increasing trend was observed in all age groups. However, the subjects studied were born after 1956, when a

Table 4. Distribution of reported symptoms in 1997 comparing telephone interview to self-completion, expressed by sex- and age-adjusted odds ratios

Question	Self-completion <i>n</i> = 715 Yes (%)	Interview <i>n</i> = 102 Yes (%)	Odds ratios (95% CI)
a.	31.7	29.4	0.87 (0.55–1.39)
b.	25.9	17.6	0.62 (0.36–1.08)
c.	16.1	8.8	0.53 (0.25–1.10)
d.	24.8	19.6	0.81 (0.48–1.39)
e.	14.0	17.6	1.49 (0.84–2.65)
f.	5.5	7.8	1.71 (0.75–3.89)
g.	4.8	4.9	1.15 (0.43–3.11)
h.	5.7	6.9	1.36 (0.57–3.47)
i.	22.7	32.4	1.89 (1.18–3.04)
j.	6.2	4.9	0.92 (0.35–2.48)
k.	3.5	2.0	0.72 (0.16–3.21)

shift toward a western lifestyle may already have taken place in Denmark. This study was not designed to elucidate factors that may have caused the observed increases.

A season-of-response effect has recently been reported on parental reported rhinoconjunctivitis in Finnish children (13). The 1-year-period prevalence of parental reported rhinoconjunctivitis was highest in the spring pollen season and lowest in the autumn (outside the pollen season). Unfortunately, the available data did not allow us to examine a possible season-of-response effect in this study. However, when the questionnaires mailed in the spring pollen season (May 1997) were excluded from the analysis, the results did not change. Since the remaining questionnaires were mailed outside the pollen season in Denmark (autumn 1997), it is unlikely that the observed increases can be explained by a season-of-response effect as described above.

Data on the daily pollen counts in Copenhagen show that the pollen season preceding the 1997 survey was mild compared to the pollen season preceding the 1989 survey (14), and therefore could not explain the observed increase in the reporting of symptoms.

Are the observed increases in self-reported symptoms followed by a true increase in allergic disease? Diagnostic criteria and awareness of symptoms may change over time. Surveys of asthma in children have reported a larger increase

in diagnosed asthma than "wheezing", suggesting an increase in the recognition of asthma (15). The wording of the questionnaire used in this study excluded diagnostic terms, such as "asthma" and "hay fever", thereby minimizing the effect of a possible change in labeling of disease. However, increasing awareness of symptoms may, at least in part, explain the observed increase. A recent review concluded that the evidence for increased asthma in children and young adults was weak because the measures used were susceptible to systematic errors (16). It is therefore important that future studies of time trends include objective measurements.

In conclusion, we found evidence of increased prevalence of allergic rhinitis symptoms associated with skin test reactivity. This suggested an increase in respiratory allergy to pollen and animal dander.

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