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BRIEF COMMUNICATION

Exposure to grass pollen – but not birch pollen – affects lung function in Swedish children

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Abstract

Allergic response to pollen is increasing worldwide, leading to high medical and social costs. However, the effect of pollen exposure on lung function has rarely been investigated. Over 1800 children in the Swedish birth cohort BAMSE were lung-function- and IgE-tested at the age of 8 and 16 years old. Daily concentrations for 9 pollen types together with measurements for ozone, NO_2, PM_{10}, $PM_{2.5}$ were estimated for the index day as well as up to 6 days before the testing. Exposure to grass pollen during the preceding day was associated with a reduced forced expiratory volume in 8-yr-olds; −32.4 ml; 95% CI: −50.6 to −14.2, for an increase in three pollen counts/m³. Associations appeared stronger in children sensitized to pollen allergens. As the grass species flower late in the pollen season, the allergy care routines might be weakened during this period. Therefore, allergy information may need to be updated to increase awareness among grass pollen-sensitized individuals.

Pollen allergy has a significant clinical impact in Europe, and several studies indicate that the prevalence has increased in the past decades (1, 2). Up to 40% of the European population is presently estimated to be sensitized to some type of pollen, and the cost of allergic diseases and symptoms is very high in terms of impaired work performance, sick leave, consulting physicians and medication (1).

Generally, the plants contributing to pollinosis are those that rely on wind as the pollen carrier. Deciduous trees, such as hazel (*Corylus*) and alder (*Alnus*), are the earliest seasonal producers of allergenic pollen in central Sweden. Depending on meteorological conditions, these species may begin to release pollen as early as February and March. Birch (*Betula* spp.), which is considered to be the main cause of pollen allergy symptoms in Scandinavia (1), typically blooms between late March and early June. The native pollen season in Scandinavia usually ends when grass (Poaceae) and mugwort (*Artemisia vulgaris*) have stopped blooming in August/September.

Population studies on pollen exposure and lung function in children are rare (3), and we have found no reports on a possible interaction with air pollution levels. In this study, we investigated the effect of nine types of pollen on lung function in 8- and 16-year-old children living in the Stockholm region.

Methods

Children belonging to the Swedish birth cohort BAMSE underwent clinical examination including lung-function testing and blood sampling for measuring serum immunoglobulin E (IgE) against common airborne and food allergens (ImmunoCAP System; Phadia AB, Uppsala, Sweden) at eight (N = 1838) and sixteen years of age (N = 2063) (year 2003–2004 and 2011–2012, respectively). A detailed description of the lung-function and sensitization measurements is provided elsewhere (4, 5). Daily measurements of pollen counts (counts/m³) for nine types of pollen (*Corylus, Alnus, Ulmus, Betula, Pinus, Salix, Quercus, Artemisia* and Poaceae) (Swedish Museum of Natural History), together with ozone, nitrogen dioxide (NO_2), particulate matter with aerodynamic diameter <10 µm (PM_{10}) and <2.5 µm ($PM_{2.5}$) from roof-level urban background monitoring stations within central Stockholm (Stockholm – Uppsala County Air Quality

Management Association), were estimated for the index day as well as up to 6 days before lung-function testing. Linear regression analyses were applied to assess associations between pollen concentrations and lung function. All results were adjusted for sex, age, height and allergic heredity. In addition, air pollution exposure was evaluated as a potential confounder.

Results and discussion

Increased exposure to grass pollen (ranging from 0 to 27 counts/m³) the day before lung-function testing was associated with a reduced forced expiratory volume in 1 s in 8-year-olds (FEV_1; −32.4 ml; 95% confidence interval; CI: −50.6 to −14.2, for an increase in three pollen counts/m³; Fig. 1). Similar associations were seen for exposure periods up to a week. The results were robust to additional adjustment for concomitant air pollution exposure. The results of forced vital capacity (FVC) were comparable to those of FEV_1, and the FEV_1/FVC ratio did not seem to be affected. The negative effect of grass pollen on lung function was found to be stronger when only children sensitized to different pollen allergens (birch, timothy or mugwort) were included in the analysis (FEV_1; −41.6 ml; 95% CI: −68.3 to −14.8). An interaction between the exposure to grass pollen and being sensitized to pollen allergens was detected ($P = 0.05$ and 0.01 for FEV_1 and FVC, respectively), indicating that the sensitized children were the susceptible group. The effect was less pronounced in children who were sensitized to only one type of pollen, which may to some extent be attributed to lower IgE levels in those individuals, compared with individuals that are sensitized to all three types of pollen (data not shown). Furthermore, as different pollen types are released at different periods of the pollen season, children sensitized to more than one type of pollen are experiencing a longer period of exposure, which may lead to a stronger effect on bronchial hyper-reactivity and reduced lung function. No associations were found for birch or other pollen exposure in the 8-year-olds. Pollen exposure was not related to lung function in the 16-year-olds.

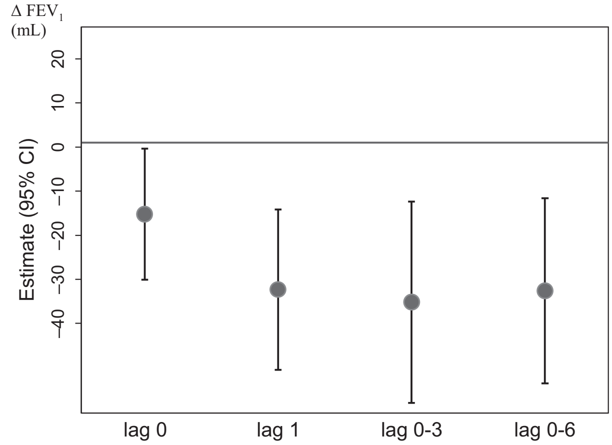

Figure 1 Exposure to grass pollen and FEV_1 in 8-year-old children of the BAMSE cohort. Results are presented for an increase in three pollen counts/m³ during up to 6 days prior lung-function measurement. Adjusted for sex, age, height and allergic heredity. Lag 0 = pollen exposure during the index day. Lag 1 = pollen exposure during the day preceding lung-function measurement. Lag 0–3 = 4-day average pollen exposure (index day – up to 3 days preceding lung-function measurement). Lag 0–6 = 7-day average pollen exposure (index day – up to 6 days preceding lung-function measurement).

Our results indicate a negative association between lung function and airborne grass pollen concentrations during the preceding week in 8-year-old children. However, as measurements of lung function were not performed during the summer (20 June – 12 August 2003, and 30 June – 6 September 2004), we are not able to judge whether the observed effects are related to an acute exposure to grass pollen or to exposure during a longer period. The lack of associations in the 16-year-olds could be an effect of physical maturation of children showing a greater sensitivity to pollen during earlier years. Another plausible explanation is that there is a development of tolerance between 8 and 16 years of age; however, we do not have data on serum-specific IgG and IgG4 against pollen to evaluate this. The percentage of time spent in- versus outdoors may also differ between 8 and 16 years of age.

Very few studies have investigated the effect of pollen on lung function. Krug et al. (6) exposed adult volunteers with allergic rhinitis to grass pollen in an experimental setup. They did not find any significant effects of grass pollen on lung function. Similarly, after following children with seasonal allergic asthma before and during grass pollen season, Roberts et al. (3) did not find any correlation between pollen levels and lung function. Thus, our finding of an inverse relation between grass pollen exposure and lung function in 8-year-old children does not support earlier data. However, the previous studies contained relatively few study subjects and only one other study was conducted in children.

Although birch pollen allergens have been suggested to be the main cause for pollen allergy in Scandinavia, only an effect of grass pollen on lung function was indicated in this study. Pollen concentrations in 2003 and 2004 were relatively low for both birch and grass. However, as the threshold level of grass pollen concentration needed to develop allergy symptoms is considered to be significantly lower than the corresponding level for birch (7), there were more days with pollen levels above this threshold for grass than for birch pollen. In previous studies, an increase in sensitivity against grass pollen has been observed as the pollen season progresses (8). This may have influenced the results as the lung-function tests in this study were conducted relatively late in the season. It is also possible that as some grass species flower relatively late in the pollen season, the allergy care routines might have weakened, as most people sensitized to pollen may concentrate their allergy-preventive behaviour to the spring months. In this case, the Scandinavian allergy information may need to be updated to increase awareness among grass pollen-sensitized individuals that their symptoms may be related to their lower respiratory tract and that treatment is likely to be beneficial.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Author contributions

Olena Gruzieva and Mare Lõhmus were the main contributors to the manuscript writing and data analysis. Göran Pershagen, Magnus Wickman and Tom Bellander contributed by frequent consultations about methodology and discussions of the results. Erik Melén and Jenny Hallberg contributed by clinical data collection. All authors contributed to manuscript writing.

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