

Allergenic exposure, IgE-mediated sensitization, and related symptoms in lawn cutters

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Aims: The aims of the study conducted on lawn cutters were: (1) to evaluate exposure to pollens and molds; and (2) to assess the prevalence rate of IgE sensitization and symptoms in relation to exposure to pollens and molds.

Methods: Environmental assessment was done with the use of personal samplers on eight workers. Our population consisted of 181 municipal park workers, including 128 lawn cutters and 67 control subjects (blue-collar workers in the hospital). A questionnaire was administered, as well as skin prick tests with seven common inhalants including pollens and eight grass molds. The main outcome variables were grass or mold sensitization (at least one of eight molds) and work-related rhinitis, conjunctivitis, and rhinoconjunctivitis. Atopy and exposure to park-related allergens, as well as sensitization to grass pollens, were considered as explanatory factors. Smoking was taken into consideration as a covariant. Both presence and duration of occupational exposure to park-related allergens were considered as parameters of exposure. Duration of exposure (months $\times$ years of exposure as lawn cutters) was used as a continuous or as a categorical variable.

Results: Environmental monitoring showed that the concentration of pollens and molds decreased in magnitude from samples collected close to lawn cutters faces, short distance away in parks, and in the general environment. There was no difference in the prevalence rates for atopy between lawn cutters (32%) and control subjects (37%). Sensitization rates to grass pollen were also similar in lawn cutters (18%) and in control subjects (22%). However, there was a tendency for prevalence rates of sensitization to molds to be greater among lawn cutters (12% to *Alternaria*) compared with control subjects (5%). In the logistic model atopy was significantly related to grass sensitization (odds ratio [OR] = 7.2), mold sensitization (OR = 9.3), and sensitization to *Alternaria* (OR = 5.8). Grass sensitization was a significant risk factor for park-related rhinitis (OR = 5.8), conjunctivitis (OR = 5.0), and rhinoconjunctivitis (OR = 9.4). Exposure for 12 years or more was associated with rhinoconjunctivitis with an OR of 4.1 (95% confidence interval, 1.0-16.7). Smoking was not significantly related to any outcome.

Conclusion: We conclude that among lawn cutters exposure to pollens and molds is higher than in the general population, atopy is the main determinant of sensitization to these aeroallergens, and sensitization and, to a much lesser extent, exposure to grass are determinants of symptoms. (*J ALLERGY CLIN IMMUNOL* 1994;93:437-45.)

Key words: Environment, occupational diseases, rhinitis, asthma

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Abbreviations used

CI: Confidence interval
OR: Odds ratio

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TABLE I. Environmental results

	Shirt	Park	General
July 2, 1992			
<i>Alternaria</i>	66	22	0
<i>Cladosporium</i>	190	18	14
<i>Epicoccum</i>	32	4	4
<i>Rust</i>	296	20	0
<i>Ustilago</i>	260	2	2
Total	924	96	32
Pollens	36	4	0
July 3, 1992			
<i>Alternaria</i>	2	20	0
<i>Cladosporium</i>	26	68	22
<i>Coprinus</i>	4	2	6
<i>Ganoderma</i>	2	14	12
<i>Ustilago</i>	2	6	2
Total	208	138	52
Pollens	2	6	10
July 6, 1992			
<i>Alternaria</i>	42	6	0
<i>Cladosporium</i>	2700	80	30
<i>Epicoccum</i>	38	2	0
<i>Rust</i>	36	0	0
<i>Ustilago</i>	862	16	12
Total	3796	118	62
Pollens	8	6	2
July 7, 1992			
<i>Alternaria</i>	22	24	4
<i>Cladosporium</i>	218	184	50
<i>Coprinus</i>	42	30	18
<i>Ustilago</i>	18	2	6
Total	308	274	114
Pollens	4	2	6
July 8, 1992			
<i>Alternaria</i>	5604	92	4
<i>Cladosporium</i>	24504	626	108
<i>Curvularia</i>	554	0	0
<i>Epicoccum</i>	920	30	0
<i>Pithomyces</i>	904	6	0
Total	33840	872	182
Pollens	84	6	0
July 9, 1992			
<i>Alternaria</i>	72	2	2
<i>Cladosporium</i>	196	14	0
<i>Coprinus</i>	24	2	0
<i>Myxomycetes</i>	42	0	0
<i>Ustilago</i>	18	2	0
Total	418	22	2
Pollens	14	0	0
July 10, 1992			
<i>Alternaria</i>	106	62	6
<i>Cladosporium</i>	720	176	102
<i>Coprinus</i>	108	40	38

All values are expressed in cubic meters; personal samples were taken with a pump run at 2 L/min, close to the mouth (shirt), in the vicinity in the park (park), and in the general environment (roof of university campus).

TABLE I. cont.

	Shirt	Park	General
<i>Rust</i>	136	50	0
<i>Ustilago</i>	266	122	12
Total	1376	520	240
Pollens	4	4	0
July 14, 1992			
<i>Alternaria</i>	56	10	2
<i>Cladosporium</i>	768	286	90
<i>Coprinus</i>	268	752	192
<i>Ustilago</i>	354	136	2
Total	1646	1406	422
Pollens	22	4	4

The determinants of sensitization to common inhalants seem to be atopy and exposure level. The increased prevalence compared with the general population of infantile eczema, urticaria, rhinitis, and asthma in parents and siblings of patients, especially in identical twins supports the theory of a hereditary predisposition.¹ Epidemiologic studies also show that exposure is a determinant in conditioning the sensitization. This is based on data from immediate skin reactivity and specific IgE antibodies in native and immigrant subjects who moved to different geographic regions² and in natives of New Guinea after mites were introduced.³ Korsgaard⁴ found a strong association between air concentrations of mites and sensitization to them in a case-control study. Although the results were not confirmed by others,^{5, 6} a more recent report showed a strong correlation between exposure to *Der p* I and *Der p* II type allergens and the risk of IgE sensitization in children and young atopic adults.⁷ Surveys of populations at risk for developing occupational asthma also suggest that the level of exposure may play a role.^{8, 9}

Lawn cutters are exposed to pollens and molds. Some may have IgE-dependent sensitization as well as nasal, conjunctival, and respiratory symptoms. The prevalence of sensitization and symptoms is unknown, and the possible roles of atopy and degree of exposure have not been determined to the best of our knowledge. Most quantitative information on pollen exposure relies on data from a few regional stations in specific places and may not accurately reflect individual exposure. Indeed, levels of airborne pollen may vary according to local climatic conditions and levels of activity.¹⁰⁻¹² Personal apparatus available for partic-

TABLE II. Anthropometric characteristics, smoking habits, and exposure characteristics by occupational group

	All park workers (n = 173)	Lawn cutters (n = 128)	Blue-collar workers (n = 67)
Sex (men, %)	159 (92%)	114 (89%)	57 (85%)
Age (yr)			
Mean $\pm$ SD	33 $\pm$ 13	35 $\pm$ 13	35 $\pm$ 12
Number < 29	79 (46%)	51 (40%)	27 (40%)
Number 30-39	39 (23%)	32 (25%)	16 (24%)
Number $\geq$ 40	55 (32%)	45 (35%)	24 (36%)
Smoking habits			
Current smokers	75 (43%)	60 (47%)	22 (33%)
Nonsmokers	66 (38%)	42 (33%)	23 (34%)
Ex-smokers	32 (19%)	26 (20%)	22 (33%)
Duration of park or blue-collar work (yr)			
Mean $\pm$ SD	8 $\pm$ 8	9 $\pm$ 8	10 $\pm$ 10
Number < 1	20 (12%)	4 (3%)	4 (6%)
Number 1-5	63 (36%)	46 (36%)	23 (34%)
Number $\geq$ 5	90 (52%)	78 (61%)	40 (60%)
Duration of exposure to grass in park (mo)*			
Mean $\pm$ SD	37 $\pm$ 47	50 $\pm$ 48	—
None	45 (26%)	—	—
< 12	30 (17%)	30 (23%)	—
12-60	27 (16%)	27 (21%)	—
60-144	33 (19%)	33 (26%)	—
$\geq$ 144	38 (22%)	38 (30%)	—

*The maximum number of months per year is 6. No significant differences between means or frequency distribution in lawn cutters and blue-collar workers were noted.

ulate sampling could be valuable instruments in acquiring a more adequate understanding of the concentrations of biologic contaminants.^{9, 13}

The aims of the study conducted on lawn cutters working in municipal parks were: (1) to determine with personal samplers the nature and concentration of pollens and molds and (2) to assess the prevalence of symptoms and IgE-dependent sensitization and relate it to possible personal and environmental determinants.

METHODS

Environmental study

For the personal air sampling, a Gilian pump run at a constant flow rate of 2 L/min for 4 hours was used. Samples were taken from three places: (1) on the employee's shirt, close to the collar; (2) in the park at an approximate distance of 25 meters from the lawn cutters but at the same elevation; (3) in the general regional environment (roof of the main campus building of the Université de Montréal at an elevation of 10 m, which represents the pollen and mold counts generally used in epidemiologic studies). One sample was obtained per

day at the three locations. The environmental study was conducted in the first week of July, when grass pollens dominate the atmospheric environment.

Epidemiologic survey

Design. The epidemiologic survey included two components: (1) a cross-sectional study of all municipal park workers who took part into the study and (2) a matched comparative study of a group of park workers, lawn cutters, and unexposed control subjects from a population of blue-collar workers in a hospital.

Subjects. A total of 181 municipal park workers employed in six different municipalities participated in the study. Eight workers responded to the questionnaire but either refused skin testing ($n = 4$) or had dermographism ($n = 4$); thus, the total number of park workers who participated in the final analysis was 173. The participation rate was 86% among the employees who were asked to participate.

A group of blue-collar workers from Sacré-Coeur Hospital was chosen as the unexposed comparison group. Sixty-seven blue-collar workers were matched with the lawn cutters by age category. They were randomly selected from a list of employees by sector of

TABLE III. Immediate skin reactivity: Distribution of subjects by occupational group

	All park workers (n = 173)	Lawn cutters (n = 128)	Blue-collar workers (n = 67)
Atopy	52 (30%)	41 (32%)	25 (37%)
Pollen sensitization			
Grass	28 (16%)	23 (18%)	15 (22%)
At least 1 pollen*	47 (27%)	34 (27%)	24 (36%)
Mold sensitization			
<i>Alternaria</i> †	18 (10%)	15 (12%)	3 (5%)
<i>Cladosporium</i>	5 (3%)	5 (4%)	2 (3%)

Atopy is defined as at least one positive skin reaction to nonoccupational allergens (e.g., house dust, *D. farinae*, and animal danders; molds include *Alternaria*, *Cladosporium*, *Epicoccum*, *Fusarium*, *Helminthosporium*, *Phoma herbarum*, *Botrytis cinerea*, and *Curvularia*).

*Tree, grass, or ragweed pollens.

†p = 0.1.

TABLE IV. Prevalence of symptoms by occupational group

	All park workers (n = 173)	Lawn cutters (n = 128)	Blue-collar workers (n = 67)
Nonoccupational symptoms			
Perennial asthma	22 (13%)	16 (13%)	2 (3%)*
Seasonal asthma	8 (5%)	6 (5%)	1 (1.5%)
Perennial rhinitis	37 (21%)	30 (23%)	14 (21%)
Seasonal rhinitis	34 (20%)	26 (20%)	14 (21%)
Work-related symptoms			
Asthma	12 (7%)	10 (8%)	2 (3%)
Rhinitis	39 (23%)	32 (25%)	9 (13%)†
Conjunctivitis	38 (22%)	30 (23%)	12 (18%)
Rhinoconjunctivitis	28 (16%)	22 (17%)	6 (9%)

*p < 0.05 as determined by chi square test for comparison of proportions of lawn cutters and blue collar workers.

†p = 0.06 as determined by chi square test for comparison of proportions of lawn cutters and blue-collar workers.

activity and were stratified by age (5-year groups) from 20 to 60 years old. The ratio of exposed lawn cutters to nonexposed blue-collar workers (128:67) was close to 2:1. The participation rate in the control population of blue-collar workers was 64%.

Questionnaire

The symptoms questionnaire used was derived from the International Union Against Tuberculosis and Respiratory Diseases standardized questionnaire on asthma.^{14, 15} Questions on symptoms (nasal, ocular, and respiratory) at work were added. An occupational history provided information on the following: duration of employment, job title, duration of work as a lawn cutter, number of hours per week spent cutting lawn, symptoms (nasal, ocular, and respiratory) at work.

Skin testing

Skin prick testing was carried out with seven common inhalants (tree, grass, and ragweed pollens; house dust, *Dermatophagoides farinae* [Omega, Montreal,

Quebec, Canada], cat and dog danders [Hollister-Stier, Etobicoke, Ontario, Canada]) with a positive (histamine phosphate, 1 mg/ml) and a negative control (diluent). Skin testing also included the following specific molds: *Alternaria tenuis*, *Hormodendrum*, *Epicoccum nigrum*, *Fusarium vasinfectum*, *Helminthosporium*, *Phoma herbarum*, *Botrytis cinerea*, and *Curvularia spicifera* (Hollister-Stier), which were selected because they are normally present on grass. Perpendicular diameters of the wheal reaction, if present, were assessed 10 minutes after the introduction of the antigen. The mean of the two diameters was used in the analysis. A wheal of 3 mm or more in diameter was considered a positive response in the absence of a reaction to the diluent (dermographism) and the presence of a reaction to histamine phosphate.

Analysis of results

Analysis and processing of filters for personal sampling. The techniques used on each filter to collect particles for microscopic examination and counting

TABLE V. Prevalence of positive skin prick test results by duration of exposure

	Exposure				
	≥ 3 months				
	< 3 months (n = 45)	3-12 mo (n = 30)	12-60 mo (n = 27)	60-144 mo (n = 33)	≥ 144 mo (n = 38)
Atopy*	11 (24%)	7 (23%)	10 (37%)	13 (39%)	11 (29%)
Grass pollens	5 (11%)	5 (17%)	6 (22%)	6 (18%)	6 (16%)
At least 1 skin reaction to tree, grass, or ragweed pollens	13 (29%)	6 (20%)	9 (33%)	9 (27%)	10 (26%)
Molds					
<i>Alternaria</i>	3 (7%)	3 (10%)	5 (19%)	7 (21%)	4 (11%)
<i>Cladosporium</i>	0 (0%)	0 (0%)	3 (11%)	2 (6%)	0 (0%)
At least 1 skin reaction to 1 mold†	4 (9%)	3 (10%)	5 (19%)	7 (21%)	4 (11%)

*Defined as at least one skin reaction to house dust, *D. farinae*, and animal danders (cat, dog).

†Includes *Alternaria*, *Cladosporium*, *Epicoccum*, *Fusarium*, *Helminthosporium*, *Phoma herbarum*, *Botrytis*, and *Curvularia*.

were as follows: sticky cubes (1 mm³) of glycerinated gelatin (30%) stained with basic red fushin (1%) were used to recover particles on the filter's exposed surface. The cubes were melted directly onto a microscopic slide over a slide warmer. The liquid sampler was then covered with a coverslip and sealed with nail polish. Particles were subsequently identified under a light microscope (×400 and ×1000). The remaining filters were submitted to a thorough wash with distilled water, and the residuum was examined for pollens or spores. No particles remained after the glycerin-gelatin sampling.

Epidemiologic survey. The main outcome variables were grass or mold sensitization (at least one of eight molds); sensitization to *Alternaria*; and work-related rhinitis, conjunctivitis, and rhinoconjunctivitis. Park workers were divided into two groups: the first group included those who had worked for at least 3 months as lawn cutters (74% of park workers) (referred to as the group with park-related allergen exposure); the other group included park workers with less than 3 months' experience as lawn cutters and those who had never held this position (referred to as the group with no significant exposure). Duration of exposure was calculated as months × years of exposure as lawn cutters and was expressed in months. This index of exposure was used as a continuous or categorical variable (five categories were defined: <3 months, 3 to 12 months, 12 to 60 months, 60 to 144 months, and >144 months). The distribution of the index of exposure among those with park-related exposure (>3 months) was done in four groups with approximately the same frequency, rounding off to the exact number of years. Smoking was considered as a dichotomous variable (nonsmokers vs current/former smokers).

Chi square analysis was used to compare prevalence

rates of outcomes of interest between lawn cutters and age-matched control subjects. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to measure the association among atopy, grass or mold sensitization, and symptoms in the 173 park workers. Multivariate logistic regression was used to assess the probability of developing symptoms in relation to atopy, grass sensitization, duration of exposure, and smoking in the 173 park workers.

RESULTS

Table I shows the environmental data collected with the personal sampling devices on 8 different days. Mold counts for which the highest daily values were recorded are listed together with the total mold and pollens counts per cubic meter. It can be seen that *Cladosporium* was the mold that was present in the highest concentration. Apart from the molds listed in Table I, other fungi such as *Agrocybe*, *Ascospores*, *Aspergillus/Penicillium*, *Cercospora*, *Drechslera*, *Fusarium*, *Leptoshpaeria*, *Nigrospora*, *Periconia* and *Torula* species were also found, but in minor quantities. Pollen counts were generally low but still higher than those in the general environment. As a general rule, the highest values for molds and pollens were found on the workers' shirts (close to the collar), the next highest were in the vicinity of the park, and the lowest were in the general environment.

Baseline anthropometric characteristics, smoking habits, and exposure characteristics are listed in Table II. Most park workers and lawn cutters were men, and their ages were evenly distributed. More than 50% of workers had been employed

TABLE VI. Prevalence of symptoms by duration of exposure

	Exposure				
	< 3 months* (n = 45)	≥ 3 months*			
		3-12 mo (n = 30)	12-60 mo (n = 27)	60-144 mo (n = 33)	≥ 144 mo (n = 38)
Asthma					
Perennial	6 (13%)	1 (3%)	7 (26%)	4 (12%)	4 (11%)
Seasonal	2 (4%)	0 (0%)	3 (11%)	0 (0%)	3 (8%)
Rhinitis					
Perennial	7 (16%)	10 (33%)	6 (22%)	6 (18%)	8 (21%)
Seasonal	8 (18%)	3 (10%)	5 (19%)	6 (18%)	12 (32%)
Park-related symptoms					
Asthma	2 (4%)	2 (7%)	3 (11%)	2 (6%)	3 (8%)
Rhinitis	7 (16%)	6 (20%)	7 (26%)	7 (21%)	12 (32%)
Conjunctivitis	8 (18%)	3 (10%)	6 (22%)	7 (21%)	12 (32%)
Rhinoconjunctivitis	6 (13%)	2 (7%)	5 (19%)	4 (12%)	11 (29%)

*By definition, those exposed for less than 3 months were considered as not having been exposed.

for more than 5 years. The duration of exposure to grass in parks (the maximum number of months of exposure in parks is 6 per year because of climatic conditions) was evenly distributed. Approximately 30% of the population of park workers and lawn cutters was atopic (Table III). Immediate skin reactivity to grass was elicited in a proportion close to 20%. Sensitization to *Alternaria* occurred in approximately 10% of the exposed workers and was more common than sensitivity to *Cladosporium*. It was three times more common in lawn cutters than in the control population of blue-collar workers, and this difference in proportions tended to reach statistical significance (chi square = 2.8, $p = 0.1$). Although the prevalence of perennial and seasonal rhinitis was similar in the exposed and control groups, there were significantly more subjects with symptoms of perennial asthma (chi square = 4.8, $p = 0.03$) (Table IV). Work-related symptoms of asthma, rhinitis, conjunctivitis, and rhinoconjunctivitis were more common in lawn cutters, although this difference tended to be significant (chi square = 3.5, $p = 0.06$) for rhinitis only.

Tables V and VI show the frequency of skin reactivity and symptoms according to duration of exposure. Statistical analysis did not reveal a trend for any of these features in terms of any association with duration of exposure. The association between symptoms and immediate skin reactivity is presented in Table VII. Atopy was a significant determinant of perennial asthma and

seasonal rhinitis and of park-related rhinitis, conjunctivitis, and rhinoconjunctivitis as shown by mean ORs greater than 2 and 95% CIs excluding 1. As shown in Table VII, skin reactivity to grass was significantly related to the same symptoms and in addition was strongly related to seasonal rhinitis. Finally, skin reactivity to molds was related to rhinitis whether it was perennial, seasonal, or work-related.

Among park workers ($n = 173$) atopy was significantly related to grass sensitization (OR = 72, 95% CI = 1.9-26.6), sensitization to *Alternaria* (OR = 5.8, 95% CI = 1.4-24.5), and sensitization to at least one mold (OR = 9.3; 95% CI = 2.3-37.8). In logistic regression models including atopy, grass exposure (continuous, categorical, or dichotomous variable) and smoking (having smoked at some point as opposed to never), atopy was the only independent variable remaining when a stepwise method was used.

In multiple logistic regression analyses that incorporated grass sensitization, exposure to park-related allergens (various parameters, taken separately), and smoking as possible explanatory variables for park-related symptoms, grass sensitization appeared to be the only factor or the most important one significantly related to the outcomes considered. In the model in which the exposure parameter was "being exposed for 12 years or more as opposed to being exposed for a lesser duration" and in which the three independent variables were forced to enter, significant ORs were obtained for grass sensitization in

TABLE VII. Prevalence of atopy and skin reactivity to grass pollen and mold according to symptomatology in park workers ($n = 173$)

Symptoms (S/A)	Atopy				Skin reactivity to grass pollen				Skin reactivity to at least 1 mold			
	S	A	OR	95% CI	S	A	OR	95% CI	S	A	OR	95% CI
General												
Perennial asthma (22/151)	12 (55%)	40 (27%)	3.3	1.3-8.3	7 (32%)	21 (14%)	2.9	1.1-7.9	5 (23%)	18 (12%)	2.2	0.7-6.6
Seasonal asthma (8/165)	5 (63%)	47 (29%)	4.2	0.9-18.2	3 (38%)	25 (15%)	3.4	0.8-15.0	3 (38%)	20 (12%)	4.4	0.9-19.6
Perennial rhinitis (37/136)	15 (41%)	37 (27%)	1.8	0.9-3.9	11 (30%)	17 (13%)	3.0	1.2-7.1	10 (27%)	13 (10%)	3.5	1.4-8.8
Seasonal rhinitis (34/139)	19 (56%)	33 (24%)	4.1	1.9-8.9	17 (50%)	11 (8%)	11.6	4.7-29	10 (29%)	13 (9%)	4	1.6-10.3
Park-related												
Asthma (12/161)	6 (50%)	46 (29%)	2.5	0.8-8.2	4 (33%)	24 (15%)	2.9	0.8-10	3 (25%)	20 (12%)	2.4	0.6-9.4
Rhinitis (39/134)	18 (46%)	34 (25%)	2.5	1.2-5.3	15 (39%)	13 (10%)	5.8	2.5-14	9 (23%)	14 (10%)	2.6	1.0-6.5
Conjunctivitis (38/135)	18 (48%)	34 (25%)	2.7	1.3-5.6	14 (37%)	14 (10%)	5	2.1-12	8 (21%)	15 (11%)	2.1	0.8-5.5
Rhinoconjunctivitis (28/145)	13 (46%)	39 (27%)	2.4	1.0-5.4	14 (50%)	14 (10%)	9.4	3.7-24	6 (21%)	17 (12%)	2.1	0.8-5.8

S, Symptomatic; A, asymptomatic.

association with park-related rhinitis (OR = 6.0, 95% CI = 1.6-22.4), conjunctivitis (OR = 5.9, 95% CI = 1.6-22.3) and rhinoconjunctivitis (OR = 12.0, 95% CI = 2.9-44.0). This therefore confirmed the results shown in Tables V and VI. Exposure for 12 or more years was a significant determinant of rhinoconjunctivitis (OR = 4.1; 95% CI = 1.0-17). Smoking was never significantly related to these symptoms.

DISCUSSION

To the best of our knowledge, no study has yet examined the environmental respiratory inhalants to which lawn cutters can be exposed. Furthermore, no epidemiologic cross-sectional survey of municipal park workers involved in lawn cutting had been carried out to determine the prevalence of nasal, ocular, and respiratory symptomatology and the frequency of immediate-type sensitization to pollens and molds. This study

also seemed relevant for determining the relative roles of atopy (personal) and exposure (extrinsic factor) in conditioning symptomatology and sensitization.

From an environmental point of view, we found that workers are exposed to various molds and that the concentration is higher than that in the general environment. The dominant mold is *Cladosporium* but other fungi such as *Alternaria*, *Coprinus*, *Curvularia*, *Pithomyces*, *Myxomycetes*, *Ustilago*, and *Rust* species are also frequently encountered. Pollen concentration is also higher than that in the general environment. Personal samplers were used. This approach showed that the concentration is higher close to the source of emission. The advantage of personal samplers has been demonstrated by others.^{9, 13} The data obtained on environmental concentrations of pollens and molds were purely descriptive, and no attempt was made to build an exposure index

including concentrations of environmental allergens. The main reason for this was that no between-individual differences were expected because the subjects under consideration held the same job (i.e., lawn cutter).

We used a cross-sectional epidemiologic study design in which comparison was made with a control group of blue-collar workers who had not worked in parks. Because we were dealing with inhalants that can be encountered in the general environment, we thought that it was important to rely on a control group to compare results obtained from a questionnaire and skin testing with the same extracts. The participation rate of the exposed population was satisfactory (86%). This does not exclude biases, the principal one being that related to all cross-sectional surveys, the healthy worker effect, which would reduce the prevalence of workers with symptoms in the exposed populations.¹⁶ We suspected, however, that this bias would be more significant for occupational asthma¹⁷ than for rhinoconjunctivitis because symptoms of asthma can be more troublesome than those affecting the other mucosa. Moreover, symptoms of rhinoconjunctivitis are only seasonal and can generally be controlled with an antihistamine or topical antiinflammatory preparation. We therefore predicted that subjects would generally remain exposed even when they had symptoms. However, we found that the prevalence of perennial asthma in lawn cutters was significantly higher than in blue-collar workers. This points away from a selection bias in the population studied. We also believed that immunologic sensitization would be even less affected by this potential bias because as many as 50% of subjects can have evidence of immunologic sensitization without having symptoms.¹⁸

The results of the epidemiologic survey with a control group of blue-collar workers suggest some enhanced risk for type I immunologic sensitization to molds and symptomatology in the exposed group, although these differences were marginal in some instances and are difficult to interpret. Although atopy was seen as frequently in the control nonexposed group as in the exposed group, immediate skin reactivity to *Alternaria*, but not to grass pollens and *Cladosporium*, was twice as common in lawn cutters. Park-related work symptoms of rhinitis tended to be more frequent in the exposed group. Although results were borderline or marginally significant from a statistical point of view, these data nevertheless suggest that immunologic sensitization to *Alternaria* and symp-

tomatology may be more common in lawn cutters. The reason that sensitization to *Alternaria*, but not to pollens or other molds, was more common is unknown. The same comment would apply to park-related symptoms of rhinitis, which were marginally more frequent, although the frequency of conjunctivitis and asthma did not seem to be significantly increased.

It is interesting to note that in park workers, symptoms of rhinitis and conjunctivitis were associated with skin reactivity to grass pollens and not to mold. This would tend to suggest that although sensitization to *Alternaria* and not to pollens was more common in the exposed population, symptomatology was more related to pollen sensitization than to mold sensitization. However, the prevalence of sensitization to molds (and to *Alternaria*) was low, and this may explain the difficulty in demonstrating a significant relationship with symptomatology.

In the specific population of park workers, we were interested in determining the relative roles of atopy and exposure in conditioning symptoms and sensitization. Atopy is clearly a determinant of sensitization and symptomatology, because park-related symptoms of rhinitis and conjunctivitis are almost twice as common in atopic subjects as in nonatopic ones. As mentioned above, sensitization to grass pollen was also related to park-related symptomatology. In our study the degree of exposure did not appear to condition the likelihood of immunologic sensitization or symptomatology, although exposure for more than 12 years was a significant determinant of rhinoconjunctivitis. These results might suggest that exposure has to be lengthy before the risk of symptomatology increases. Our workers were exposed for only 6 months a year because of climatic conditions. Studies in subjects who are continuously exposed might confirm these findings because they would likely include subjects with longer exposures than our lawn cutters. More generally, our results confirm previous findings concerning the relative roles of atopy and exposure in IgE-mediated sensitization, which is the result of a complex interaction of genetic and environmental factors. Atopy plays a determinant role, as reviewed by Pepys¹⁹ and confirmed by studies in identical twins and in atopic families.¹ As discussed in the introduction, the role of exposure in determining IgE-mediated sensitization to house dust and mites is still controversial.⁴⁻⁷ However, we recently showed that atopy, much more than the degree of exposure, was the principal determinant in the

development of symptomatology as a result of exposure to domestic pets.²⁰

We conclude that lawn cutters are exposed to higher concentrations of molds and pollens than those found in the general environment. However, this seems to increase their risk of immunologic sensitization and symptomatology only marginally, if at all. Atopy and skin reactivity to grass pollens are the main determinants of symptomatology, although exposure may play a role, especially in those exposed for longer periods.

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