

Flowers and other trigger factors in asthma and rhinitis – an inquiry study

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Six hundred and eighty adult patients with asthma and/or rhinitis were questioned about symptoms elicited by 46 different flowers and 10 common non-specific environmental trigger factors listed in a questionnaire. Flowers or birch twigs were reported to elicit symptoms in 79% of the patients, somewhat more often in rhinitis than in asthma patients, and caused symptoms as often in non-atopics as in atopics. Birch twig and marguerite most frequently induced symptoms, followed by strongly smelling flowers such as hyacinth, lilac, and lily of the valley. Unspecific irritants caused symptoms in 98% of the asthmatics and in 67% of patients with rhinitis. Tobacco smoke and perfumes were the most important troublemakers. A significant positive correlation was found for elicitation of symptoms from flowers and from certain non-specific irritants. It is concluded that non-specific hyperreactivity as well as reaginic hypersensitivity are the mechanisms involved when birch twigs and flowers elicit symptoms.

Key words: airways irritants; allergic rhinitis; bronchial asthma; environmental factors; flowers.

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CLINICAL ASPECTS

The study shows that flowers elicit symptoms as often in non-atopic patients as in atopics. A history of asthma or rhinitis induced by flowers, other than those belonging to the *Asteraceae* family, indicates unspecific hyperreactivity of the airways and not a reagin-mediated pollen allergy. Flowers with a strong smell, as well as birch twigs and flowers belonging to the *Asteraceae* family are most likely to give problems and should not be recommended in hospitals. Tobacco smoke and perfumes often induced symptoms, and medical staff in contact with asthmatic patients should not smell of tobacco or strong perfume.

Patients with bronchial asthma or rhinitis often report that symptoms are elicited by flowers and other plants. In some cases reagin-mediated pollen allergy is obviously the mechanism involved (16). In other cases odorants or irritants originating from the flowers appear to elicit the symptoms (4, 6, 13).

The aim of the study was to produce a ranking list of flowers based on their symptom-inducing capacity. We have questioned 680 patients with asthma and/or rhinitis about symptoms elicited by various flowers. We further enquired about symp-

toms from environmental factors known to induce symptoms by non-allergic mechanisms. The answers were placed in relation to the patients' type of airways disease and atopic status.

PATIENTS AND METHODS

The patient material consisted of 680 individuals suffering from asthma and/or rhinitis, attending the outpatient departments of the clinics taking part in the study. Details about the patients are shown on Table 1.

Table 1

Patient details

	Males/Females	Asthma only	Rhinitis only	Asthma and rhinitis	Age, years (mean and range)
Non-atopics	35/87	48	48	26	41 (15-84)
Atopics	263/295	42	267	249	30 (8-82)
Total	298/382	90	315	275	33 (8-84)

The patients' atopic status was evaluated on the basis of their history in combination with skin prick tests with common inhalant allergens (house dust, mite, animal danders, and pollen from birch, timothy, and mugwort), in some cases supplemented with RAST or provocation tests. A patient was considered to have allergy, i.e. to be atopic, if he or she had a positive case history in combination with positive prick test or RAST. In the absence of a positive history, a $\geq 3+$ skin prick test (i.e., a wheal of at least the same size as that of the positive histamine reference), a Phadebas RAST® class ≥ 2 , or a positive provocation test was regarded as evidence of allergy.

All patients were asked to fill out a questionnaire regarding symptoms elicited by 46 different flowers (and birch twigs), (see Table 3) as well as 10 other environmental factors known to cause airway symptoms ("unspecific factors" see Table 5). For each flower or unspecific factor the patients were asked to answer with one of the following alternatives: "severe trouble" "moderate trouble", "slight trouble", "no trouble" or "I don't know". A colour atlas of flowers was available to those who were unsure of the names.

Table 2

Prevalence of symptoms from flowers and birch twigs in various patient groups

	Prevalence of symptoms (%) in patients with		
	rhinitis only	asthma only	asthma and rhinitis
Atopics	83	66	85
Non-atopics	73	51	77

Significance of difference:

Between atopics and non-atopics $P < 0.001$

Between asthmatics and rhinitis patients $P < 0.001$

Statistics

When calculating the prevalence of patients to get symptoms from a flower or unspecific factor, those who answered "I don't know" were excluded. To take into account the severity of symptoms elicited by the various flowers, a "severity score" (SS) was calculated as follows: $SS = 3 \times sev + 2 \times mod + 1 \times sli$ where *sev*, *mod* and *sli* indicate number of patients with severe, moderate, and slight symptoms. For statistical analyses Pitman's non-parametric permutation test was used (5).

Since there were reciprocal influences between atopic status, airway diagnosis and sex (e.g. there were more patients with rhinitis than asthma among atopics), a non-parametric partial correlation test, which could eliminate such influences, was used for analyses of correlations between various patient groups (5, 15). As an expression of the degree of correlation Spearman's correlation coefficient (R) was used.

More than 4000 *P*-values were calculated, thus to minimize the problem of mass significances, a significance level of 0.1% ($P < 0.001$) was chosen. This means that 4 of the significant correlations found could be obtained only by chance.

RESULTS

Atopic status

Most patients (558) were atopic and 122 non-atopic. Of the 558 atopic patients 65% were allergic to grass, 57% to birch, 43% to mugwort, 41% to animal dander, 28% to house dust, and 14% to house dust mites.

Table 3
Prevalence and severity of symptoms from various flowers in atopic and non-atopic patients

Rank No. Flower (English and Latin)	Prevalence (%) of symptoms								Scores ¹
	Atopic patients				Non-atopic patients				
	Slight	Moderate	Severe	Total	Slight	Moderate	Severe	Total	
1. Birch twigs (<i>Betula alba</i>)									
with catkins	13	33	40	86	21	25	36	82	841
without catkins	17	25	21	63	25	18	18	61	497
2. Marguerite (<i>Leucanthemum vulgare</i>)	17	26	24	67	23	15	10	48	511
3. Hyacinth (<i>Hyacinthus orientalis</i>)	19	13	12	44 ²	23	24	26	73 ²	382
4. Lilac (<i>Syringa vulgaris</i>)	21	14	10	45	25	15	21	61	326
5. Lily of the valley (<i>Convallaria majalis</i>)	12	15	8	35	15	22	15	52	275
6. Broom (<i>Cytisus</i> spp)	15	9	10	34	18	11	14	43	205
7. Mimosa (<i>Acacia</i> spp)	11	9	9	29 ²	33	7	24	64 ²	200
8. Stock (<i>Matthiola incana</i>)	10	7	8	25	21	16	16	53	146
9. Marigold (<i>Calendula officinalis</i>)	12	9	7	28	9	9	4	22	156
10. Pelargonium (<i>Pelargonium hortorum</i>)	13	7	3	23	15	15	4	34	143
11. Freesia (<i>Freesia tubergenii</i>)	8	6	6	20	12	12	21	45	141
12. Tagetes (<i>Tagetes</i> spp)	10	7	6	23	17	7	7	31	131
13. Narcissus (<i>Narcissus poeticus</i>)	10	5	4	19	16	20	4	40	128
14. Chrysanthemum (<i>Chrysanthemum morifolium</i>)	9	8	5	22	15	9	4	28	122
15. Forsythia (<i>Forsythia</i> spp)	11	7	3	21	22	2	10	34	108
16. Primula (<i>Primula</i> spp)	6	8	4	18	14	7	7	28	106
17. Sweet pea (<i>Lathyrus odoratus</i>)	12	4	1	17	17	13	4	34	88
18. Daffodil (<i>Narcissus pseudonarcissus</i>)	10	5	3	18	16	12	2	30	113
19. Cornflower (<i>Centaurea cyanus</i>)	5	8	4	17	7	0	5	12	92
20. Aster (<i>Aster</i> spp)	7	6	4	17	7	4	2	13	88
21. Carnation (<i>Dianthus</i> spp)	5	4	4	13	9	8	4	21	92
22. Rose (<i>Rose</i> spp)	7	3	1	11	11	9	2	22	76
23. Coltsfoot (<i>Tussilago farfara</i>)	6	3	5	14	0	0	0	0	68
24. Petunia (<i>Petunia</i> spp)	5	4	1	10	9	7	0	16	52
25. Peony (<i>Paeonia</i> spp)	7	1	2	10	6	6	0	12	44
26. Begonia (<i>Begonia</i> spp)	5	2	1	8	4	4	2	10	50
27. Larkspur (<i>Delphinium</i> spp)	5	3	1	9	0	7	3	10	29
28. Tulip (<i>Tulipa</i> spp)	3	3	1	7	7	0	0	7	44
29. Windflower (<i>Anemone nemorosa</i>)	5	1	1	7	2	6	0	8	39
30. Violet (<i>Viola</i> spp)	5	1	0	6	7	4	0	11	31
31. Poinsettia (<i>Euphorbia pulcherrium</i>)	2	2	0	4	0	8	4	12	39
32. Paulownia (<i>Saintpaulia ionatha</i>)	5	2	0	7	2	2	2	6	32
33. Iris (<i>Iris</i> spp)	2	1	2	5	5	5	2	12	32
34. Dahlia (<i>Dahlia cultorum</i>)	3	2	2	7	3	0	0	3	31
35. Columbine (<i>Aquilegia vulgaris</i>):	2	2	1	5	4	4	0	8	23
36. Geranium (<i>Pelargonium asperum</i>)	1	2	2	5	7	4	0	11	24
37. Calceolaria (<i>Calceolaria</i> spp)	2	2	2	6	0	2	0	2	32
38. Bridal veil (<i>Gypsophila paniculata</i>)	4	1	1	6	0	3	0	3	23
39. Gladiolus (<i>Gladiolus gandavensis</i>)	3	1	0	4	5	3	0	8	17
40. Crocus (<i>Crocus vernus</i>)	3	0	1	4	2	2	0	4	24
41. Azalea (<i>Rhododendron simsii</i>)	2	1	1	4	2	0	0	2	17
42. Anemone (<i>Anemone</i> spp)	1	2	1	4	3	0	0	3	18
43. Pansy (<i>Viola wittrockiana</i>)	3	1	0	4	2	2	0	4	17
44. Amaryllis (<i>Hippeastrum hortorum</i>)	2	0	1	3	0	0	0	0	15
45. Cyclamen (<i>Cyclamen persicum</i>)	2	0	0	2	2	2	0	4	12
46. Snowdrop (<i>Galanthus nivalis</i>)	0	0	0	0	2	0	0	2	4

¹Score = No. of patients with *severe* symptoms × 3 + No. of patients with *moderate* symptoms × 2 + No. of patients with *slight* symptoms.
²Statistically significant (*P* < 0.001) difference between atopic and non-atopic patients.

Missing data in questionnaires

A considerable number of patients answered “I don’t know” to one or several of the questions, mainly regarding flowers not known by the patients. The number ranged from 35 (symptoms from tobacco smoke) to 449 (symptoms from larkspur). Male patients answered “Don’t know” more often than females to the questions regarding flowers. The following results are calculated from the answers of patients who knew whether or not they got symptoms from the factors and flowers in question.

Flowers and birch twigs

Flowers and/or birch twigs caused symptoms in 79 % of the patients. Such symptoms were more common in patients with rhinitis (82 %) than in asthmatics (57 %) and more frequent in atopics (82 %) than in non-atopics (68 %) ($P < 0.001$) (Table 2). Flowers alone were reported to elicit symptoms in 18 %, both flowers and birch twigs in 48 %, and birch twigs alone in 13 %. Flowers were found to elicit symptoms more often in non-atopics than in atopics.

Table 3 lists the frequency, in rank order, with which flowers and birch twigs were reported to elicit symptoms. Birch twigs top the list, causing symptoms in 86 % of the patients, followed by marguerites (64 %) and hyacinths (49 %). Hyacinths and mimosa elicited symptoms more often in non-atopics than in atopics ($P < 0.001$).

Relationship between specific allergies and symptoms from flowers and birch twigs

Of patients who were proved birch pollen-allergic, 96 % reported symptoms from birch twigs with catkins and 69 % from birch twigs without catkins. The corresponding figures for non-birch-allergic patients were 66 % and 46 % respectively ($P < 0.001$ for the difference between birch pollen-allergic and non-birch pollen-allergic patients).

Patients with test-verified allergy to pollen from the *Asteraceae* family (mugwort) reported adverse reactions to marguerite more often (80 %) than patients without *Asteraceae* pollen allergy (43 %) ($P < 0.001$).

Reciprocal relationship between symptoms from various flowers

When correlation coefficients (R) were calculated between the different flowers and birch twigs, the values of R ranged from 0.00 (e.g. saint paulia/larkspur) to 0.83 (amaryllis/daffodil). With the exception of birch twigs and marguerite high correlation coefficients ($R > 0.40$) were found between flowers topping the ranking list shown in Table 3. An example is shown in Table 4 where the figures for symptoms from hyacinth are compared with those from other flowers.

Among flowers at the bottom of the rank list, the highest R value was found for the combination columbine/larkspur ($R = 0.78$).

Unspecific factors

Significantly more of the asthmatics (98 %) than of the rhinitis patients (67 %) reported symptoms from one or more of the unspecific factors ($P < 0.001$). There was no difference between atopics and non-atopics. The prevalences of adverse reactions caused by the various unspecific factors are shown in Table 5. Tobacco smoke and perfume top the list, followed by damp, cold, and carpets. Each of the unspecific factors, with the

Table 4
Correlation between symptoms from hyacinth and symptoms from other flowers and birch twigs

Flower	Prevalence (%) of symptoms in patients		Correlation coefficient (R)
	without symptoms from hyacinth	with symptoms from hyacinth	
Birch twigs			
with catkins	78	90	0.20
Marguerite	52	74	0.27
Lilac	16	79	0.67
Lily			
of the valley	7	72	0.75
Broom	11	61	0.57
Mimosa	10	66	0.63
Stock	9	56	0.60
Marigold	11	43	0.40
Pelargonium	7	43	0.48

Significance for all the correlation coefficients: $P < 0.001$

exception of perfumes, printing ink, heat, and fir trees, caused symptoms significantly more often in asthmatics than in rhinitis patients ($P < 0.001$).

Reciprocal relationship between various unspecific factors

When symptoms from each unspecific factor were correlated to each of the other unspecific factors, statistically significant correlations were found for all combinations ($P < 0.001$). The highest R-

values were obtained with the combinations damp/cold and cooking odours/candle ($R = 0.51$), perfume/printing ink ($R = 0.48$), perfume/tobacco smoke ($R = 0.47$), perfume/carpets ($R = 0.44$) and perfume/cooking odours ($R = 0.41$).

Relationship between symptoms from flowers and unspecific factors

Patients complaining of symptoms from one or several of the unspecific factors noticed symp-

Table 5
Prevalence and severity of symptoms elicited by various unspecific factors

	Prevalence (%) of symptoms					Prevalence of symptoms (%) in patients with			Significance of difference be- tween asthma- tics and rhinitis patients ²
	Slight	Moderate	Severe	Total	Score ¹	asthma only	rhinitis only	asthma and rhinitis	
1. Tobacco smoke	22	22	13	56	667	72	41	67	*
2. Perfume	20	21	7	48	509	61	36	57	NS
3. Cold	12	14	12	38	475	74	12	53	*
4. Damp	14	18	10	42	470	68	18	60	*
5. Carpets	20	15	7	42	372	44	28	55	*
6. Printing ink	17	10	4	31	292	38	25	36	NS
7. Heat	13	9	4	27	263	39	19	32	NS
8. Fir trees	11	4	4	19	173	23	15	22	NS
9. Cooking fumes	10	6	2	18	171	38	7	23	*
10. Candles	4	4	2	10	98	23	3	12	*

¹Score = See explanation in Table 2
²NS = non-significant; * $P < 0.001$

Table 6
Correlation between symptoms from perfumes and symptoms from some of the flowers

Flower	Prevalence of symptoms (%) in patients		Correlation coefficient for comparison between perfumes and the flowers	Significance for correlation coefficient
	without symptoms from perfumes	with symptoms from perfumes		
Birch twigs with catkins	82	89	0.15	NS
Marguerite	62	69	0.11	NS
Hyacinth	21	76	0.58	*
Lilac	19	75	0.57	*
Lily of the valley	12	63	0.54	*
Broom	14	58	0.47	*
Mimosa	10	62	0.57	*
Stock	11	53	0.49	*
Marigold	16	38	0.24	*
Pelargonium	12	38	0.32	*

NS = not significant; * $P < 0.001$

toms from birch twigs or flowers with roughly the same prevalence (80 %) as patients without symptoms from unspecific factors (77 %). However, when individual unspecific factors were compared with individual flowers, several significant correlations were found. Some of the flowers (hyacinth, lilac, lily of the valley, mimosa, stock, tagetes, narcissus, and sweet pea) showed strongly significant correlation ($P < 0.001$) with each of the nine unspecific factors, the highest being perfumes and carpets. Figures illustrating the correlation between perfumes and some of the flowers are given in Table 6.

Intensity of flower scents

After studying the patients' reports we attempted a rough estimate of the intensity of the different flower scents. We therefore asked florists and nursing staff to grade the scents according to a 3-grade scale. The results are shown in Table 7.

DISCUSSION

In allergic airways diseases, diagnostic *in vivo* or *in vitro* tests can often supplement, but never replace the patients' own histories. This is especially true for many environmental trigger factors which do not exercise their effects via reagenic antibodies. For this reason, questionnaire studies are necessary for mapping out the relative importance of various symptom-provoking factors. In the present study reports of

symptoms elicited by 46 different flowers as well as 10 unspecific airway irritants were collected via questionnaires answered by 680 patients with asthma and/or rhinitis.

The main findings can be summarized as follows:

1. Unspecific irritants cause symptoms more often in asthmatics than in patients with rhinitis.
2. Of the unspecific factors listed, tobacco smoke and perfumes are the most important troublemakers.
3. Flowers and birch twigs elicit symptoms more often in patients with rhinitis than in asthmatics and in both non-atopics and atopics. Some flowers (hyacinth and mimosa) cause adverse reactions more often in non-atopic than in atopic patients.
4. Patients who get symptoms from certain unspecific irritants often get symptoms from flowers as well. Significant mutual correlations also exist between various unspecific factors as well as between various flowers.

Although the results of this study cannot explain the mechanism by which various flowers and unspecific factors cause symptoms, some suggestions are possible.

1. Reagenic (specific) hypersensitivity

Some of the plants included in our questionnaire are known to induce IgE-mediated symptoms (type I allergy). Thus hay fever caused by birch pollen allergy is very frequent in Sweden (12) and birch twigs topped our list of symptom-inducing plants. A significant correlation was also found between symptoms from birch twigs and test results with birch pollen allergen. Mugwort, belonging to the *Asteraceae* family, is also a well-known inducer of hay fever in our country. Eight flowers in our study belong to the same botanic family: marguerite, marigold, tagetes, chrysanthemum, cornflower, aster, coltsfoot and dahlia. Since cross-reactions occur within the *Asteraceae* family (16), it is possible that all or some of these flowers could induce symptoms by the same mechanism as mugwort. Symptoms from

Table 7

Estimate of the intensity of flower scents according to an inquiry among hospital staffs and florists

Strong	hyacinth, lilac, lily of the valley, broom, mimosa, stock, freesia, tagetes, narcissus, sweet pea, peony, pelargonium
Moderate	marguerite, marigold, geranium, daffodil, carnation, rose, violet
None	poinsettia, paulownia, columbine, calceolaria, bridal veil, amaryllis, cyclamen, snowdrop

marguerite, number two in our ranking list, correlated significantly with mugwort pollen allergy.

According to recent reports not only pollen, but also other plant components can induce IgE-mediated symptoms (2). We do not know if such non-pollen allergy can explain some of the flower-induced symptoms reported by our patients. However, the fact that symptoms from flowers were most common in non-atopic individuals and that flowers with the strongest smell most often induced symptoms, strongly indicate that other than allergic mechanisms are involved.

2. *Non-specific hyperreactivity*

Our knowledge of non-allergic mechanisms is limited. Clinically, however, it is well known that numerous factors of a chemical or physical nature can induce airways symptoms in sensitive individuals. For the lower airways the concept bronchial hyperreactivity has been established and includes these non-allergic mechanisms. For the upper airways nasal hyperreactivity may include corresponding mechanisms. This reactivity may also include the olfactory sensory system since smelling substances are often involved.

The 10 unspecific factors on our list induced both nasal and bronchial symptoms, but for six of the factors (tobacco smoke, damp, carpets, cold, cooking fumes and candles) the prevalence was significantly higher in asthmatics than in rhinitis patients. All these factors, except cold and damp, are of chemical nature and may induce symptoms by a direct chemical influence on the hyperreactive mucosa. For the other factors, physical stimuli induce symptoms. Cooling of the lower airways (cold), fluid loss and change in osmolarity (damp, cold) can induce bronchoconstriction in asthmatic patients (1, 8).

The degree of bronchial hyperreactivity can be measured by standardized histamine and methacholine inhalation tests (7, 14), and the relationship between the response to these agents and symptoms from common airway irritants can be established. In such a study it

was shown that the response to methacholine correlated significantly with symptoms from exercise (cooling of the airways, fluid loss and change in osmolarity) but was not correlated to symptoms from cigarette smoke and perfume (3). Thus it seems that methacholine as well as histamine tests may reflect the overall reactivity of the bronchi, but do not reflect the sensitivity to single environmental factors. This underlines the importance of considering the patients' own history of sensitivity.

With the exception of marguerites, the flowers topping our ranking list are those with the strongest scent as estimated by florists and nursing staff (Table 7). Flowers with no scent elicited symptoms in only a few patients. The mechanism involved when smelling substances induce symptoms in the airways is mainly unknown. It could be speculated that the olfactory sensory system plays a considerable role since strongly smelling flowers and perfumes are important inducers of symptoms. These agents may cause reflex-induced symptoms via the olfactory nerve (10). A case of angioedema provoked by olfactory stimuli has been reported (17). The reaction could be prevented by blocking the sense of smell with a local administration of 4% cocain solution. Besides flowers and perfumes, many other sources of smell and odor are known to elicit airways symptoms (10).

It is also possible that the olfactory system has nothing to do with the elicitation of symptoms. It may only register the scent whereas the smelling substances could act directly on the mucosa like other chemical substances. A strong smell might parallel stronger irritant effects on the mucosa.

Since it has been shown that asthmatic patients often mislabel symptoms (9), another possibility could be that the symptoms recorded by the patients are not real symptoms of rhinitis or asthma but only unpleasant smells. Although this may be possible and in some cases be connected with conditioned reflexes or other psychological mechanisms, this theory is not likely, since most patients, like healthy people, think that the scent of flowers and perfumes is pleasant.

The finding that birch twigs and flowers very

often elicit symptoms in non-atopic patients has diagnostic implications. For example, although the patients' histories are often conclusive for the diagnosis of reagin-mediated birch pollen allergy they can also lead to false positive diagnoses. Several patients report allergic symptoms during the springtime as well as when exposed to birch twigs, strongly suggesting a specific birch pollen allergy, but they nevertheless have negative skin tests, RAST and provocation tests with birch pollen allergen (12).

The results of this study support prophylactic measures so often proposed by asthmatics. Flowers and other environmental factors which can worsen their asthma should not be allowed in hospitals where patients with airway diseases are treated. Flowers and birch twigs constitute a problem not only in hospitals but also in other public places. Rhinitis and asthma are common diseases and many persons working in hospitals and other places are in fact hypersensitive. For example, an inquiry made at one of the clinics taking part in this study indicates that about 10% of the staff are allergic to birch pollen (11).

Conclusions

The results are primarily applicable to Scandinavia. The following recommendations should therefore be slightly modified according to the local flora before being used in other parts of the world: Birch twigs and flowers with a strong scent as well as flowers belonging to the *Asteraceae* family should not be recommended in hospitals, unless patients and personnel with airway problems can be protected in other ways. Advice about suitable flowers (natural or synthetic) for hospitals should preferably be given in cooperation with the local florists.

Since tobacco smoke and perfume belong to the unspecific irritants that most often elicit symptoms, medical staff in contact with asthmatic patients should not smell of tobacco or strong perfume. Smoking should not be allowed and floor carpeting should not be recommended in hospitals and other public places.

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