

ENVIRONMENTAL CONTROL OF OUTDOOR ALLERGENS

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ABSTRACT

Outdoor allergens are an important cause of allergic rhinitis, conjunctivitis and asthma, with pollens and moulds being the major outdoor allergens that induce symptoms in atopic patients. Grass pollens are the predominant pollen in South Africa. Rising levels of atmospheric air pollution are linked to the exacerbation of allergic disease. Although pollens and outdoor fungal spores are impossible to avoid completely, measures can be taken to reduce exposure in the outdoor environment and reduce the amount of allergen entering indoors in order to improve disease control.

Key words: outdoor allergens, mould, pollen, aeroallergens, air pollution, allergic disease, sensitisation

POLLENS

Pollens are the male reproductive cells of most plants.¹ Intact pollens range in size from 10–100 µm, but most have diameters between 20–35 µm.² Pollen counts are generally lowest after rain and highest on warm, windy days.³ The association between pollens and the onset of allergic disease as well as exacerbations has been reported in several studies.⁴

Pollen allergy predominantly causes rhinoconjunctivitis because the pollens are filtered mainly by the nasal mucosa and do not reach the alveoli as a result of their large particle size. However, pollen grains may rupture on contact with water, releasing starch particles containing the allergens that are small enough to reach the alveoli.² Some grass allergens may bind to diesel-exhaust carbon particles, leading to deposition in the airways.⁵ Even though many asthmatics are sensitised to various pollen types, pollen sensitisation has not been associated with an increased risk of having asthma, although pollen exposure has been associated with asthma exacerbations.⁶

MOULDS

Moulds require warmth, moisture and organic debris to grow, with both the spores and the mycelia being allergenic.¹ They are potent triggers for asthma, as most fungal spores range in size from 2 µm to 10 µm and they are therefore able to penetrate the lower airway.^{1,7} Mould counts are usually higher in the evening and rise after rain.^{1,3} Although mould is a perennial allergen, there are seasonal spikes.¹ *Alternaria* and *Cladosporium* species are the major outdoor allergens responsible for sensitisation.⁸

Mould spores have been found to increase the risk of bronchial hyper-responsiveness and asthma symptoms in children.⁶ *Alternaria* sensitivity has been found to be a risk factor for severe asthma attacks and epidemic asthma.⁹

OUTDOOR AEROALLERGENS IN SOUTH AFRICA

In the Western Cape, the most abundant perennial aeroallergens are fungal spores, the most common fungi being *Alternaria*, *Cladosporium* and *Epicoccum*.¹⁰ The highest fungal spore levels are recorded during spring and autumn.¹¹ Grass pollens are perennial allergens, but peak in October–December.¹⁰ Tree pollens are seasonal allergens: oak pollen peaks in August, plane tree in September and pine in October.¹⁰

On the Highveld, the grass-pollen season is from September to May, with a mid-summer peak. The tree-pollen season is short (October–November).¹¹ In the Free State, grass and maize pollen are the most common sensitising allergens in patients with allergic rhinitis (AR) and asthma, with the rate of sensitisation to tree pollen being much lower.^{12–14} *Alternaria* is the mould with the highest rate of sensitisation in the Free State.¹⁵

In KwaZulu-Natal, grass pollen is the predominant outdoor aeroallergen, with pollen levels peaking in spring and summer, while fungal spores are a perennial allergen.¹¹ In Mpumalanga, grass-pollen levels peak in January, whereas fungal-spore levels peak in February.¹¹

Sensitisation to grass pollen and the development of hay fever and/or seasonal conjunctivitis is more common in urban than rural environments.¹⁶ Tree, weed and flower pollen are less common as causes of allergy in South Africa as compared to Europe.¹⁶

POLLUTION

Air pollution exposure is associated with increased rates of allergic sensitisation and exacerbation of allergic disease.^{2,17} Exposure to ambient air pollutants in early childhood plays an important role in the exacerbation of asthma and other respiratory symptoms.⁴ Truck traffic near residences is associated with AR symptoms.¹⁸ Pollutants that can cause rhinitis and asthma include particulate matter, ozone (O₃), nitrogen dioxide (NO₂) and sulphur dioxide (SO₂).^{19,20} In this regard, South African ambient air-quality standards are not as stringent as World Health Organisation (WHO) standards for particulate matter, SO₂ and O₃.²¹

Airborne particulate matter consists of a mixture of small particles of organic and inorganic compounds, acids, metal, dust and carbon. Particulate matter is categorised according to size; particulate matter₁₀ includes particles smaller than 10 µm that can bypass the nasal and pharyngeal-filtering processes to reach the bronchioles and alveoli, while particulate matter_{2.5} particles are smaller than 2.5 µm and can therefore extend further and lead to cardiopulmonary impairment.²⁰ The primary source of particulate matter is fossil-fuel combustion emissions, although mine dumps are a major contributor to particulate-matter air pollution in surrounding communities.^{17,22} A high prevalence of wheeze and rhinoconjunctivitis has been found in communities living near mine dumps.²² Particulate matter is more common in urban environments, where there are more confined motor-vehicle emissions and industrial exposure.²⁰

Diesel exhaust is an important component of urban particulate matter, with particle sizes ranging from nanoparticles to large, coarse particles. The immediate response to exposure is similar to a type 1 hypersensitivity response, with histamine release within minutes of exposure and increased cellular inflammation and chemokine production occurring within hours. Long-term exposure has been associated with possible increased allergic sensitivity to other allergens.²⁰ Pollen allergens may bind to diesel-exhaust carbon particles, leading to delivery into the lungs.⁵

O₃ is generated at ground level by a chemical reaction of sunlight on mixtures of NO₂ and hydrocarbons from fossil-fuel combustion.¹⁹ Major sources of O₃ include vehicular traffic, power plants and industrial operations.¹⁹ O₃ can increase airway inflammation and hyperresponsiveness;¹⁹ exposure to it irritates the respiratory epithelium, is associated with decreased lung function, increased symptoms, increased rescue-medication use and increased risk of asthma exacerbation; and it may interact with allergens to cause a greater asthmatic response.^{19,20} An association has been found in children between O₃ exposure, wheeze and AR, as well as an increased rate of newly developed sensitisation to outdoor allergens.²³

Motor-vehicle exhaust, industry, power plants and forest fires are the main sources of atmospheric NO₂.¹⁹ This gas is associated with increased asthma symptoms, exacerbations and

hospitalisations, and also with lower-lung function.¹⁹ Long-term exposure to NO₂ exacerbates bronchitis symptoms in asthmatic children.²¹ SO₂ is an ambient air pollutant formed mainly by the combustion of high-sulphur coal or oil; it can cause reduced lung function.¹⁹

ENVIRONMENTAL CONTROL PRACTICES

Although allergen avoidance is seldom effective on its own as a way of controlling atopic disease, it forms an important part of its management, because reducing exposure can help medical therapy to work more effectively. Unfortunately, pollens and outdoor fungal spores are impossible to avoid completely. Allergen exposure may occur in the outdoor environment or when allergens enter the indoor environment. Allergen avoidance is therefore based on advising patients about when to enter the outdoor environment and about preventing outdoor allergens from entering the indoor environment (see Table I).¹

TABLE I: ENVIRONMENTAL CONTROL MEASURES

- Avoid outdoor activities during peak pollen and mould periods.
- Keep doors and windows closed and use air conditioning.
- Change clothing when returning home.
- Wash outdoor pets before they come indoors and keep them out of bedrooms.
- Mould-sensitive patients should avoid contact with decomposing leaves, grasses and grains and avoid camping or walking in forests.

POLLENS

Pollen levels are highest in the morning, especially on hot, dry, windy days.¹ During the pollen season, outdoor activities should therefore preferably be planned for the late afternoon or evening.

Measures that can be taken to prevent outdoor allergens entering indoors include keeping windows and doors closed. Patients should remove their clothes and shower immediately when they return home and change into clothes that are not worn outdoors, as pollen may stick to the clothing, skin and hair.¹ High-efficiency particulate air (HEPA) filters can reduce pollen in the home.⁹ Outdoor pets should also be kept out of bedrooms and should be washed after spending extended time outdoors, because they can bring allergenic pollen and mould into the house.¹ Although these measures may reduce the amount of pollen entering the home, pollen allergens can accumulate in house dust and remain beyond the grass pollen season.⁵ Frequent vacuuming is necessary to reduce this potential source of exposure.

MOULDS

Mould spores are also most prevalent on dry, windy days, but levels are higher in the evenings and after rain.^{1,3,24} Mould-sensitive patients should avoid contact with decomposing leaves, grasses and grains and avoid camping or walking in forests or densely vegetated, deep-shade areas, especially during autumn and winter.²⁴ It is not possible to eliminate mould from the outdoor environment, but dense vegetation close to the house should be thinned out and dead or decaying trees and bushes should be removed. Stagnant water near the house should also be drained.¹

POLLUTION

It is hard to avoid outdoor air pollution because there is no realistic way of avoiding exposure.⁸ When the air quality is poor, patients should avoid exertion and stay indoors, preferably in an air-conditioned environment.¹⁹ Clean-air policies are the most effective way to reduce the health effects related to air pollution.⁸

CONCLUSION

Pollens and moulds are the predominant outdoor allergens causing allergic conjunctivitis, rhinitis and asthma. Although it is

impossible to avoid these allergens completely, some measures can be introduced to reduce exposure in order to improve disease control.

DECLARATION OF CONFLICT OF INTEREST

The author declares no conflict of interest.

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