



Dannemiller KC, Conrad LA, Haines SR, Huang YJ, Marr LC, Siegel JA, Hassan S, King JC, Prussin AJ, Shamblin A, Perzanowski M 2024. Indoor bioaerosols and asthma: Overview, implications, and mitigation strategies. *Journal of Allergy and Clinical Immunology*, **155**(3), 714-725. doi: 10.1016/j.jaci.2024.11.027

Abstract

Aerosolized particles with a biological origin are called bioaerosols. Bioaerosols from plants, animals, fungi, bacteria, and viruses are an important class of environmental exposures that are clinically relevant to asthma. However, there are important differences in the pathways by which various bioaerosols affect asthma. Additionally, differences in individual susceptibility to different bioaerosols affect exposure reduction and mitigation strategies. Strategies to reduce exposures to potential triggers of asthma are routinely considered as part of standard clinical care and asthma management guidelines. Ventilation standards in buildings may reduce bioaerosol exposure for everyone, but they are not necessarily designed specifically to protect patients with asthma. Direct measurement of a bioaerosol is not generally necessary for practical applications where the relevant source of the bioaerosol has been identified. Different types of bioaerosols can be controlled with similar strategies that prioritize source control (eg, reducing resuspension, integrated pest management, controlling moisture), and these can be supplemented by enhancing air filtration. The goal of this review is to summarize the latest information on bioaerosols, including allergens, fungi, bacteria, and viruses, that have been associated with adverse asthma outcomes and to discuss mitigation options.



Figure 1. Bioaerosols originate from many biological sources. Exposure is also influenced by natural and mechanical ventilation.

| Bioaerosol | Sources | Asthma Outcomes Linked to Exposure | Best Control Strategies |
|----------------------------|---|--|---|
| Allergens | Plants, pests, pets, fungi, and other biological sources | Allergic response in sensitized individuals, asthma exacerbations | Source removal supplemented by air filtration in some cases |
| Dampness & Mold | Fungal growth from excess moisture | Asthma exacerbation, other negative respiratory effects. Some early-life exposures to normal fungi (not growing due to excess moisture) may be protective. | Moisture control. Mold growth may require professional remediation. |
| Bacteria | Occupants, pets, outdoor air, excess moisture in some cases | Infection from pathogens, wheezing. Some early-life exposures may be protective, but many may have no associated health outcomes | Moisture control, disease transmission control measures for pathogens |
| Viruses | Infected individuals | Respiratory disease leading to asthma exacerbations and possibly asthma development | Respiratory viral disease control measures such as masking and staying home when sick. Air filtration may help. |

Figure 3. Bioaerosol summary information.

Best Practices in Bioaerosol Exposure Reduction

Recommendations for controlling bioaerosols to reduce exposures to those with asthma depend on the asthma trigger, the patient, and the environment. However, the following general guidelines can be applied:

- Source control approaches should be prioritized first. These might include:
 - Encapsulated bedding (dust mites)
 - Integrated pest management (cockroach allergens)
 - Removing pets from sleeping environment
 - Controlling moisture to prevent mold growth
- Filtration (room-based or centralized) has shown benefit for both reducing bioaerosol exposures and asthma outcomes.
- Ventilation can be used to dilute asthma triggers with indoor sources (eg., cat allergens), however note that ventilation standards (eg., ASHRAE 62.2 for residential buildings) are not targeted specifically for asthma triggers.
- UV irradiation is sometimes used to control pathogens, although there is yet limited direct evidence for the use of UV systems to reduce asthma frequency and severity (and there is some concern about ozone production with some UV installations).

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