

Clinical Commentary Review

Procedures to Assist Health Care Providers to Determine When Home Assessments for Potential Mold Exposure Are Warranted

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Drawing evidence from epidemiology and exposure assessment studies and recommendations from expert practice, we describe a process to guide health care providers helping their patients who present with symptoms that might be associated with living in damp housing. We present the procedures in the form of a guided 2-part interview. The first part has 5 questions that triage the patient toward a more detailed questionnaire that reflects features of housing conditions known to be reliably associated with exposures to mold and dampness contaminants. We chose the questions based on the conditions associated with moisture problems in homes across the United States and Canada. The

goal is to facilitate the clinician's effort to help patients reduce exposure to environmental triggers that elicit symptoms to better manage their disease. Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2016;■:■-■)

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In 2004, the Institute of Medicine's (IOM) Committee on Damp Indoor Spaces and Health conducted a comprehensive literature review and concluded that there was sufficient evidence of an association between damp indoor environments and persistent upper respiratory tract symptoms, namely cough, wheeze, and asthma in persons with allergic sensitization to fungi.¹ Subsequent epidemiologic and mechanistic studies have refined and extended these findings.²⁻⁴ For the epidemiology research discussed here, dampness has been most commonly associated with the simultaneous occurrence of 3 factors: visible water damage or stains, visible mold, and odors from microbial growth.² The American Society of Heating, Refrigeration, and Air Conditioning (ASHRAE) concluded "that the presence of all three factors is therefore useful as an interim definition for a damp building."⁵

The air in a clean and dry building contains spores and spore and mycelial fragments of the fungi present in outdoor air^{6,7} as well as other outdoor air contaminants.⁸ Fungal spores and fragments can enter the living space of a building from the outside air through intentional openings in the building envelope such as open windows and doors, as well as fresh air intakes of forced air ventilation systems on commercial buildings. Importantly, exposures to fungi in outdoor air are associated with significant impacts on asthma.⁹ Fungal growth inside of a building envelope tends to occur in microenvironments containing nutrients and moisture sufficient for spore germination leading to subsequent growth into colonies and eventual generation of additional spores and hyphae. This is known as colonization, and applies to actively growing colonies (ie, fungal growth) and dormant or dead colonies (also fungal growth). The more the fungal growth in a building, the greater the proportion of spore and mycelial fragments compared with intact spores in the air.^{10,11}

Using a weight of evidence approach, 3 recent reviews considering the implementation of interventions combining elimination of moisture intrusion and removal of moldy items concluded that comprehensive remediation measures reduce

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Abbreviations used

AHS- American Housing Survey

ASHRAE- American Society of Heating, Refrigeration, and Air Conditioning

CI- Confidence interval

IEP- Indoor environment professional

IOM- Institute of Medicine

OR- Odds ratio

WHO- World Health Organization

fungal exposure and consequently respiratory symptoms and asthma morbidity.^{2,3,12} However, as with reviews of other environmental allergens (such as dust mites, rodents, and cockroaches), none have shown that asthma development can be prevented by reducing these exposures.¹³⁻¹⁵ Nonetheless, the position that prevention or remediation of fungal growth indoors can reduce respiratory disease symptoms has been adopted by several prominent panels and health agencies.^{1,4,16,17} This is an important public health issue in that the maximum attributable risk for asthma associated with fungi and dampness has been estimated at 20%.^{18,19}

The intent of this review is to discuss fungi and dampness inside buildings and provide evidence-based questions useful to determine when home visits are warranted to assess potential fungal exposure. Ultimately, the goal is to reduce exposure to fungi and fungal products from growth inside the building.

PROVIDER-FACILITATED HOME ASSESSMENT

Although many issues related to fungi and dampness can be managed by the patient with the guidance of a health care professional, there are situations where consultation with a trained indoor environment professional (IEP) is necessary. However, it is not practical or necessary for all patients to have such an assessment. Recognizing that assessments are inconvenient for the occupant, currently expensive, and may be unnecessary or inconclusive, what is needed are criteria for determining which patients and which homes would most likely benefit from a home assessment.

Because the evidence above indicates that patients who have respiratory illnesses (eg, asthma and rhinitis) are at increased risk of developing symptoms from exposure to fungal growth and dampness, such individuals might benefit from a home assessment if increased exposure to fungal growth is suspected. Other considerations for a home assessment include the following:

- Has the patient lived in the home long enough for respiratory symptoms to occur in response to indoor fungal exposure? The biologically relevant time period for exposure to occur and lead to many types of symptoms or disease onset is not known. A history of increased symptoms after occupancy of a home would be evidence of a relevant exposure.
- Is the patient likely to occupy the home for long enough to justify the assessment? If the patient plans to move to another home in the near future, an assessment might not be justified.
- Does the patient have enough control of the environment to implement interventions (ie, remediate or otherwise change the occupied space) if necessary? Although it may help to understand what indoor exposures are present, such knowledge is less useful if interventions cannot be performed easily as may be the case for a rental unit or subsidized housing.

However, evidence of significant exposure might encourage the landlord to perform necessary interventions or the patient to move to a different home.

TOOLS TO DETERMINE IF A HOME ASSESSMENT IS WARRANTED FOR FUNGI AND DAMPNES

In cases where possible fungal-related illness is reported, a 2-step process (parts A and B described below) is recommended to decide whether or not there is justification for a building assessment focused on moisture and/or fungal growth issues. The first step is for clinicians to consider asking key questions to determine whether the common facilitative factors associated with environmental exposure to moisture and fungal growth may be present.²⁰ Part A (shown in Figure 1) includes 5 questions for the clinician (or designate) to administer to a patient with confirmed symptoms that are consistent with an increased likelihood of exposure to fungal growth. They are not specific to fungal exposure, so dust mites and other relevant allergens should also be considered.¹³⁻¹⁵ A positive reply to all 5 questions in part A is sufficient indication for the need of a home assessment. However, any one of these indicators may justify the application of part B (shown in Figure 2) by an allied health professional (or designate) to aid in the decision whether or not to recommend a home assessment for the patient. A majority of answers in the red section of part B (ie, first column) indicate that a home assessment might be helpful to understand potential sources of dampness and pathways of exposure to fungal growth.

Rationale for including 5 questions in part A

The first 4 questions have been used in several epidemiologic studies of allergy and asthma over the years.^{1,3,4,21} However, many of the questions were often considered for proxies of other allergen exposures that can occur in damp buildings, namely those from dust mite allergens.^{22,23} Therefore, to assess associations between dampness characteristics with fungal levels in the indoor environment, studies have incorporated one or more types of fungal measurement including culture (to identify and quantify propagules), spore counts (including viable and nonviable spores), fungal cell components (eg, glucan and ergosterol), and molecular methods such as next generation sequencing. The fifth question is more recent and reflects increased interest in major flooding events. Furnishings (visibly moldy or otherwise) that are transported into a new home could serve as a source of biologically relevant exposure (via spores and fungal fragments), even when a new home is relatively dry.

Each of the epidemiology and exposure assessment studies used different variations of these first 4 fungi and/or dampness questions, so we sought to find questions that were standardized and had been cognitively tested for comprehension. Therefore, we chose questions that have been used in the American Housing Survey (AHS). The US Census Bureau conducts the AHS every 2 years to assess the quality of housing in the United States. AHS is a national representative survey that collects data on an average of 55,000 US housing units, including apartments, single-family homes, and mobile homes. The methodology of this survey has been described in more detail elsewhere.²⁴

When an AHS question was not available, we focused on the most commonly used and plainly written versions of questions that were used in peer-reviewed epidemiology and exposure assessment studies.

Here is a detailed explanation for each of those 5 questions:

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