

# Evaluating Damp Houses with the Environmental Relative Moldiness Index (ERMI) and Fungal PCR: A Review of the Epidemiologic Evidence

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## 1 Introduction

Evident dampness and mold are widespread in homes, and associated epidemiologically with asthma and allergy. Measured microbiologic contaminants have not been associated consistently with health effects, although some in dust have had suggestive associations (Mendell et al. 2011). A set of “mold-specific quantitative polymerase chain reaction” (MSQPCR) assays for specific fungi in indoor residential dust, interpreted with the “Environmental Relative Moldiness Index” (ERMI), has been promoted commercially to identify unusually high levels of moisture-related mold problems in homes in order to guide health-protective actions, based on published U.S. Environmental Protection Agency (EPA) studies. ERMI scores reflect two groups of fungi – those associated with water-damaged houses and respiratory illness, and those not so associated. The epidemiologic basis of this use has not been reviewed to date.

## 2 Materials/Methods

This analysis reviews epidemiologic findings on use of indices or scales with MSQPCR to assess associations between mold and health. Relevant articles were identified in PubMed and in reference lists of identified articles.

## 3 Results

Five identified eligible studies used indices to combine MSQPCR concentrations of multiple fungi (Table 1). Some studies found specific fungi associated with water damage or health outcomes; other studies found associations for different or for no fungi. Vesper et al. (2006) reported an odds ratio (OR) of 5 for high values on a Relative Mold Index (RMI) and asthma, from a flawed study design comparing homes

with asthmatic children and visible water damage to homes with neither (i.e., control homes also selected explicitly for lack of exposure). Vesper et al. (2007a) reported an unadjusted OR of 2.53 for respiratory illness and higher RMI, with the RMI threshold derived from the data. Vesper (2007) reported an unadjusted OR of 1.46 for higher ERMI scores (derived from the RMI) and asthma. In the best designed study using ERMI, unadjusted relative risks (RRs) of 1.02 and 1.32 for association of higher ERMI scores with moderate asthma and severe asthma, respectively, can be estimated from reported data (Vesper et al. 2008). RRs of 1.02 and 1.32 for current asthma are less than the OR of 1.56 from a meta-analysis of subjectively assessed “visible dampness or mold” and asthma (Fisk et al. 2007).

Table 1. Studies associating indices based on MSQPCR findings with health outcomes

Reference	Exposure Scale	Health Outcome
Vesper et al. 2004	unnamed	IPH*
Vesper et al. 2006	RMI	asthma
Vesper et al. 2007a	RMI	wheeze or AR**
Vesper et al. 2007	ERMI	asthma
Vesper et al. 2008	ERMI	asthma

\* idiopathic pulmonary hemorrhaging

\*\* allergic rhinitis

Selection of the two groups of fungi used for both RMI and ERMI (fungi associated with water-damaged homes, and fungi not associated) was apparently based on two sets of homes in one city: homes with infants with a rare, fatal disease and also with severe moisture problems, vs. reference homes with no disease and no evident moisture and mold (Vesper et al. 2004). The logic for this was not apparent. Other data

have apparently not been used to revise these two groups of fungi, or the algorithm for constructing the index score, before recommending ERMI for U.S. houses generally.

Surprisingly, the ERMI's construction explicitly excludes any fungal species not commonly found in both houses with and those without water damage/mold (or with and without respiratory disease). Logically, it would seem that species found only in homes with and rarely in homes without water-damage (or with and without respiratory disease) would be the *most* valuable species of all to include.

These studies associating MSQPCR-based indices with health, while suggestive, have either used clearly or potentially inappropriate comparison groups, set thresholds based on observed data without later replication, used scales other than the current ERMI, or found weak associations. No specific result has been clearly replicated. The most recent study (Vesper et al 2008) displays improved design over earlier studies (Vesper et al. 2004; 2006).

#### 4 Discussion and Conclusion

It is not clear what the current ERMI scale indicates, as it was apparently designed to distinguish houses with both an extremely rare respiratory disease and water damage and mold from those with neither, in one U.S. city.

An index or scale for interpreting MSQPCR throughout the U.S. for guiding health-protective actions in homes arguably should

- be based on multiple well-designed epidemiologic studies from multiple geographic locations, with *disease-based* comparison groups and adjustment for confounding factors.
- be constructed to optimally distinguish homes with disease from homes without.
- be more strongly associated with increased risks of specific respiratory diseases than are other (especially if simpler and less costly) available methods of assessing residential mold and moisture for guiding health-protective actions.
- include, as appropriate, fungal species that distinguish homes with disease from control homes, even if absent in control homes.

Evidence thus does not support assessing mold-related health hazards in homes using the current ERMI instead of subjective dampness and mold (e.g., are water damage, visible mold, or mold odor evident?). Fungal PCR in dust samples has potential as a basis for standardized assessment of health risks from fungi in buildings, as do summary indices/scales using these findings. However, more rigorous evaluation based on multiple well-designed epidemiologic studies will be necessary to validate specific indices or interpretation strategies of fungal PCR for predicting mold-related health risks.

#### 5 References

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