MOLD AND HEALTH ISSUES

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ABSTRACT

Over the past decade, there has been extreme media attention to issues about mold and allegedly adverse effects. Unfortunately, misinformation about mold and health effects abounds and often the public is led to believe that exposure to mold is a dangerous event. This paper presents common points of misinformation about mold and health. Scientific documentation to refute the misinformation is presented.

KEYWORDS : mold, health, indoor concentrations, outdoor concentrations

INTRODUCTION

Mold has been in existence since the emergence of plants and animals on the earth. Mold is ubiquitous in our environment. Those who study molds believe that there are nearly 1.5 million different species spanning hundreds of diverse genera (Levin 1996). There are benefits to having mold in our environment. Mold promotes natural decay of plants and animals. It is used to produce desirable foods, e.g., cheeses, and medicines. Mold moves into an indoor setting via natural and mechanical ventilation, on the fur and paws of pets, on shoes and clothing of humans, on plants brought into the indoor environment. When there is water incursion in a building, the enhanced wetness on building materials influences the growth of molds.

The most commonly detected molds include *Cladosporium, Aspergillus, Penicillium, Alternaria,* and *Fusarium.* Recently, additional attention has been given to *Stachybotrys* - a mold that, contrary to common belief, is found both indoors and outdoors. Some of these molds are generally detected in soils -*Aspergillus and Penicillium.* Others are commonly detected in association with trees - *Cladosporium, Alternaria,* and *Fusarium. Stachybotrys* is often associated with moldy grain.

Because there are no standard guidelines indicating acceptable levels of mold in the indoor environment, resolving issues, such as when mold should be removed and the appropriate extent of the removal, have been left to professional judgments or even the whims of those newly engaged in mold remediation without supporting scientific information about levels causing health problems. There are two longstanding reasons to remove mold from a building - one is for asthetic reasons (e.g., remove visible mold from walls) and a second is concern about structural damage. Most recently a third reason has emerged - health concerns. Due to the media hype of health concerns, homes and commercial buildings have been abandoned, burned or demolished. Recommended clean-up levels have been set so low that no structure in the

world would likely meet the guidelines. Law suits abound with health allegations about effects caused by exposure to low level mold.

MOLD MISINFORMATION

There are several statements that appear in the news and visual media, in building evaluation reports, and legal claims purporting to some aspect of the mold issue. Yet, none of this misinformation can be supported by scientific or medical literature or documentation. The following are a few of the major points of misinformation.

One should be concerned about indoor ambient air concentrations > 200 colony forming units (CFU)/m^3 or > 1000 spores/m^3.

Because there are no standard guidelines about acceptable levels of mold in the indoor environment, those charged with cleaning up mold infestation are left to their own devices when determining an acceptable level. Unfortunately, rarely is the decision based on surveys of structures where the occupants believe themselves to be in good health, unaffected by exposure to mold. Recently there have been investigations of such structures with some surprising results (Gots et al. in press, Shelton et al. 2002). A review of literature reporting on indoor ambient air in 820 residences without any health complaint revealed an average of 1,252 CFU/m^3 while the associated average outdoor level was reported as 1,524 CFU/m^3 (Gots et al., in press). For 85 homes with concentrations reported as total spore counts, the average ranged from 68 to 2,307 spores/m^3 for the indoor ambient air and a range of 400 to 80,000 spores/m^3 in outdoor ambient air.

As measured by the National Allergy Board of the American Academy of Asthma, Allergy, and Immunology (AAAAI 2002a), mold spore levels in cities around the country show remarkable geographic and seasonal variation. Examples of outdoor seasonal and geographical variability observed in 2001 are presented in Table 1. Some promoters of mold misinformation encourage residential and commercial building owners to complete extensive remediation when indoor mold levels are below outdoor concentrations and even when the indoor level is < 1,000 spores/m^3 or > 200 CFU/m^3. An important fact concerning measurements of indoor mold levels is that such measurements generally are taken not to identify potential health risks but rather to determine whether there is a source of water that would enhance mold growth. Thus a rule of thumb recommended by Dr. Harriet Burge of Harvard is that if indoor measurements are two times (2x) the outdoor level or greater than 1,000 spores/m^3, then a source for mold amplification should be suspected (Burge 1996). She also cautioned, however, these high levels do not mean that any occupants are at an increased health risk.

Exposure to mold can cause a diverse range of adverse health effects from non-specific symptoms (e.g., fatigue and headache) to brain damage. Toxic molds cause adverse health problems.

Two types of reactions have been well documented as being associated with mold exposure - allergic responses, e.g., hayfever, and infections in individuals with improperly functioning immune systems. In rare cases, hypersensitivity pneumonia has been associated with mold

exposure in particularly sensitive individuals. These effects, however, have been observed only when the mold exposure concentration is very high. Mold present at typical indoor

TABLE 1 Outdoor Mold Spore Levels in Selected US Cities, 2001

Location	Mold Count	Season of Measurement
St. Louis, MO	395 to 24,5000 spores/m^3 5,266 to 68, 855 spores/m^3	March to June September to December
Las Vegas, NV	8 to 673 spores/m^3 15 to 1 86 spores. m^3	March to June September to December
Albany, NY	9 to 1,534 spores/m^3 1 ,975 to 18,005 spores/m^3	March to June September to December
Santa Barbara, CA	544 to 33,090 spores/m^3 767 to 555,833 spores/m^3	March to June September to December

Source: AAAA1 2001 a.

environmental levels has never been shown scientifically to cause any other illness (Robbins et al. 2000, ACOEM 2002, Kuhn and Ghannoum 2003).

The term "toxic mold" is a misnomer. Thousand of different compounds (mycotoxins) are produced by molds to which we are exposed daily, both indoors and outdoors. A single mold can produce several to a hundred chemicals potentially toxic to animals and humans (Gots and Pirages 2002). Several different molds may produce the same toxin. For example, *Alternaria* is found outdoors on plant leaves and generally is considered by promoters of mold misinformation to be benign, i.e., not toxic. Yet, this species produces 80 different chemicals, some of which are demonstrated to be quite toxic.

Occupational exposures illustrate the lack of scientific/medical credibility of health concerns associated with low level exposures. Such occupational exposures, via handling materials of natural origin, can be extremely high. At sawmills, maximum airborne concentrations have been reported as 1,500,000 CPU/ m^3 (Duchaine 2000). Concentrations measured at honeybee overwintering facilities are reported as 2,200 to 13,931 CFU/m^3 while workers are sweeping up dead bees, from 300 to 54,700 CFU/m^3 when cleaning equipment and from 238 to 1442 CFU/m^3 before disturbance by workers (Sigler et al. 1996). A study of differences in air concentrations on farms with and without disease revealed an average exposure concentration of 120,000,000 spores/m^3 on the control farms (Malmberg et al. 1993). Daily spore levels associated with adverse health effects were at least 10 times greater. Air concentrations in spawning sheds on mushroom farms have been reported as high as 100,000 spores/m^3; even greater concentrations are detected at other areas on these farms (Lacey and Crook 1988). Fungi detected in the breathing zone of workers in a municipal waste composting facility reach levels of 8,200,000 CFU/m^3 (Lacey and Crook 1988).

At this point, a mold-toxin dose sufficient to result in adverse health effects for humans in a non-occupational environment is not known conclusively, but there are preliminary clues. A recent evidence-based statement prepared by the American College of Occupational and Environmental Medicine (ACOEM 2002) used a no-effect dose obtained from a study using rats as the test animal to derive a corresponding human dose for a continuous 24-hour exposure to *Stachybotrys chartarum* (the most highly toxigenic strain found in an indoor environment). The resulting no-effect dose for a human infant is 2,100,000 spores/m^3; for a school-age child, it is 6,600,000/m^3 and for an adult, it is 15,300,000/m^3. The ACOEM characterized these concentrations as the lower bound estimates, meaning that the assessment was conservative and the amount that actually could lead to an injury might be even higher. Another preliminary clue is given by the National Allergy Bureau of the AAAAI (AAAAI 2002b). Their web-site presents definitions of mold levels in outdoor air that may cause sensitivity to individuals as illustrated in Table 2.

TABLE 2 Outdoor Mold Concentrations Expected to Cause Some Respiratory Effects.

Category of Exposure	Mold Count	Expected Outcome
Low	1 - 6,499 spores/m^3	Only individuals extremely sensitive to these molds will experience symptoms.
Moderate	6,500- 12,999 spores/m^3	Many individuals sensitive to these molds will experience symptoms.
High	13,000 -49,999 spores/m^3	Most individuals with any sensitivity to these molds will experience symptoms.
Very High	> 50,000 spores/m^3	Almost all individuals with any sensitivity at all to these molds will experience symptoms; extremely sensitive people could have severe symptoms.

Source: AAAAI 2001 b.

Stachybotrys is the most dangerous of molds and has been known to cause hemorrhage in the lungs of infants.

Three papers purported to show a connection between newborns with bleeding lungs and the presence *of Stachybotrys* in the indoor environment (Dearborne et al. 1997, Etzel et al. 1997, Montana et al. 1997). Several of the authors were associated with the Centers for Disease Control and Prevention Agency (CDC). When the CDC evaluated the full range of data underlying these three studies, it concluded that the data compiled in these studies were inadequate to support a hypothesis of a cause and effect relationship (CDC 2000). Moreover, no further clinical evidence of this disease has emerged, despite the increasing number of homes found to contain levels of the *Stachybotrys* mold.

Exposure to Stachybotrys and other fungi results in brain damage. If Stachybotrys is detected anywhere in a building (i.e., in the indoor ambient air or within interstitial walls), extensive remediation is urgent.

Several investigators have associated the reporting of headaches, memory loss, lack of concentration, and other similar non-specific symptoms as being evidence of brain damage caused by alleged (non-documented) mold exposure (e.g., Gordon et al 2001, Johanning et al. 1999). There is no scientific or medical evidence that concentrations *of Stachybotrys* or any other mold detected in the indoor ambient air or present on building materials causes neurological or neuropsychiatric damage (Fung and Hughson 2003, Page and Trout 2001, Robbins et al. 2000, Terr 2001, Kuhn and Ghannoum 2003, ACOEM 2002).

It is highly unlikely that there is a home in which some *Stachybotrys* spores could not be detected, if sufficient testing were conducted on building materials and within wall cavities. This mold has been detected in both indoor and outdoor ambient air, in both residential and commercial building in which occupants do not have any health complaints associated with the presence of mold (e.g., Harrison et all 992, Hawthorne et al. 1989, Shelton et al. 2002). Thus, the mere detection *of Stachybotrys* does not automatically require costly remediation. The need for remediation will depend upon the concentrations at which any mold is detected, the location of detected molds, and identification of a viable exposure pathway.

Self-reported symptoms are indicators of mold exposure.

Many of the epidemiological studies claim a causal association between mold exposure and adverse health effects do not have documented indoor ambient air concentrations (e.g., Gordon et al. 1999, Johanning et al. 1999). Rather these studies rely on self-reported symptoms as a surrogate of measured mold concentrations in indoor ambient air. Because these self-reported symptoms are non-specific in nature (e.g., headaches, fatigue, muscle pain, etc.), it is not possible to identify specific chronic, diagnosed diseases based on these symptoms alone. There is nothing available in the scientific or medical literature that supports a view that such self-reported symptoms are valid surrogates for measured exposure.

Symptoms are frequently over-reported when people believe their health has been threatened. A review of the scientific literature regarding self-reported symptoms indicates that these can be unreliable when perceived hazards exist as a basis for confirming health problems. Numerous authors have studied and reported upon the unreliability of self-reported symptoms, particularly following perceived toxic exposures (e.g., Gots et al 1992, Lees-Haley and Brown 1992, Kaye et al 1994, Lipscomb et al 1992, Pennebaker 1994). The most important reason given for this unreliability is the well-known phenomenon of "reporting bias" (e.g., Last 1992, Hennekens and Buring 1987, Pennebaker 1994). "Reporting bias" is a standard epidemiological term, and not meant as a pejorative. Rather, it refers to the normal human tendency to connect physical phenomenon with unrelated causes, particularly when the perceived cause is viewed as a health threat.

Toxic fungal syndrome is associated with exposure to mold in the indoor environment,

One supporter has coined the term "toxic fungal syndrome" to refer to a broad constellation of non-specific adverse health outcomes allegedly caused by mold exposure. There is no standard medical diagnosis for this phenomenon. The term simply represents a collection of undocumented, self-reported symptoms that have no scientific or medical basis as being associated with mold exposures.

CONCLUSION

Despite the considerable attention given by the public and media to exposure to molds and adverse health effects, the literature indicates that such exposures are rather minor at potential indoor ambient air concentrations. There is no doubt that mold exposure can lead to allergic reactions and infections for some specific populations. However, there is no scientifically valid evidence that mycotoxins or mold present in indoor ambient air can lead to brain damage, cancer, chronic fatigue syndrome, fibromyalgia, or a generalized group of nonspecific symptoms. The diversity among mold genera, the types and range of mycotoxin potency, the inability to quantify mycotoxin levels in the indoor ambient air, and the flaws in epidemiological studies all contribute to a lack of evidence for a cause-effect relationship between exposure to mycotoxins and/or molds in the indoor ambient air environment and clearly defined health outcomes. Further, basic principles of toxicology and dose-response concepts argue against any potential toxicity from indoor exposure.

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