EDITORIAL

Mold, Mycotoxins, and their Effects in Children

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Climate change signifies unexpected weather in many if not most areas of the planet. Over the last several years, there have been a number of floods and hurricanes in Louisiana, Texas, the Gulf Coast, New York, and in other parts of the world. The danger lies not only in the immediate disastrous and damaging effects, but also in the health hazards from mold infested homes, schools, businesses, and public buildings.[1]

Molds grow on wet surfaces and sporulate. They produce spores of different colors. For example, the famous black spores are produced by the mold Stachybotrys, red spores by Aspergillus, Rhodotorula, and Fusarium, grey spores by Botrytis, and blue-green spores by Penicillium.[2] Molds can grow on dry wall, attics, basements, underside of carpeting, ventilation ducts, and crawl spaces among others.[3]

Testing of an indoor space for airborne mold spores reveals what is present at the time of the testing, not 24/7, and can vary hour by hour depending on the activity in the room. It does not divulge any hidden mold, such as those in wall cavities, attics, in ventilation ducts, and others. It is important to note that the Environmental Protection Agency (E.P.A.) cautions that 50% of fungal growth can be hidden, meaning hidden from sight.[3]

Diseases caused by fungi are called mycoses, and fortunately, they are not a communicable disease.[4] Mycoses have increased substantially over the last 4 decades as a result of the AIDS pandemic and the advent of chemotherapy, transplantation, immunosuppression, access to the vascular system, as well as climate change as mentioned above.[2]

Children have been increasingly affected as well. A study from Harvard University looked at 13 369 children aged 8 to 12 years old in 24 different communities throughout North America and found that there was mold growth in 22% to 54% in the households in 5 communities with asthma symptoms in 3 to 11% of the children.[5] Another study from Russia on 5951 children in 9 cities with water damage and molds in the home demonstrated a positive association with asthma, dry cough, wheezing, and bronchitis.[6]

In a study conducted in Poland on 277 infants born at term and exposed to molds for 2 or more years in mold contaminated homes, there was a deficit in intelligence quotient (IQ) compared to that in controls.[7]

More important and relevant to humans of all ages are mycotoxins from molds, which are dispersed by airborne fungal spores and fragments. Water damaged homes have shown concentrations of mycotoxins that are at least 1000 times or greater than the indoor air mold spore count. Mold spore measure from 4 to 20 microns in diameter, whereas mycotoxins measure 0.1 microns.[3]

Disease associated with exposure to mycotoxins is known as the "Great Masquerader" of the 21st century by the World Health Organization. This is because it involves different tissues and resembles different diseases.[8,9] Regrettably, the many symptoms that patients including children affected by molds and mycotoxins complain of, and the possible overlap with other diseases, leave many colleagues to believe that there is no link between exposure to molds and mycotoxins and immune and autoimmune response and disorders.

Mycotoxins can be absorbed via the nasal mucosa, the lungs, and skin. Mycotoxins attach to the nasal mucosa where they are transported via the olfactory nerve and enter the brain. In the lungs, mycotoxins enter the surfactants of the lungs and transported through the alveolar membranes where they enter the systemic circulation.[3]

In children, mycotoxicosis can present with a variety of nonspecific clinical signs and symptoms such as conjunctivitis, epistaxis, cough, wheezing, apnea, nausea and vomiting, and rashes. In some cases, acute pulmonary hemorrhage, bone marrow failure and recurrent apnea and/or pneumonia have been reported after exposure to mycotoxins.[8,10,11,12]

In a study on 482 children in Spain, psychometric testing at age 4 in children exposed to mycotoxins starting at age 3 months linked home dampness in a child's bedroom with significant decrease in the general cognitive score on both the McCarthy Scales of Child Abilities and the California Preschool Social Competence Scale.[13]

Studies have shown that school buildings are particularly vulnerable to indoor air problems14. Increasing numbers of teachers have had their health adversely affected by working in damp moldy environments. There has been escalating and growing documentation of teachers with occupational illnesses related to working in school building with successive

respiratory diseases, sarcoidosis, and occupational asthma.[14,15] It would follow then that schoolchildren would also be affected. In the United States, the Occupational Health and Safety Administration estimates that about 15% of schoolchildren may be affected by exposure to molds and mycotoxins.[15]

A recent study compared 47 pupils aged 6-15 years of age from a water-damaged school with elevated mold levels to 56 pupils from a school without water damage. The relative risk (RR) ratios for neurological or neuropsychological problems = 63.04; musculoskeletal pain RR = 58.28; headache RR = 31; respiratory symptoms RR = 22.64, fatigue RR = 21.45.[16]

A number of studies on mold and mycotoxin exposed groups have shown altered neurological functioning, including balance problems, delayed reaction time, blink-reflex latency, abnormal color discrimination, visual field abnormalities compared with controls. The exposed groups also suffered from depression.[17-21] It would be logical to assume that children's developing neurological system would also be affected. Children are more susceptible to mycotoxins as they have a lower body mass, higher metabolic rate, and underdeveloped organ functions and detoxification processes.

In children with long term exposure to molds and mycotoxins, clinical and neurobehavioral changes were significantly elevated in questionnaires, in addition to abnormalities on neurophysiological tests, including electroencephalograms (EEG), brain stem evoked potentials, visual evoked potentials, and somatosensory evoked potentials. In a study on adolescents with exposure to molds and mycotoxins, 70% had abnormal EEG's as compared to controls. Brainstem auditory evoked potentials were abnormal in 90% of the patients compared to none in controls and in visual evoked potentials the results were abnormal in 40% of cases. Sensory latencies of the median, ulnar, and sural nerves bilaterally were abnormal in 50% of cases as compared with none in the controls. These findings indicate evidence of diffuse polyneuropathy, indicating significant neurological deficits in all the adolescents.[22,23]

Medical and scientific evidence has recently connected mycotoxins to the pathogenesis of autism spectrum disorder (ASD).[24] The effects of mycotoxins can be directed by different parts of the immune system and includes the secretion of pro-inflammatory cytokines, especially from mast cells.[25-27] Exposure to molds and mycotoxins can affect the nervous system both directly and via the stimulation of immune cell activation, which together contribute to neurodevelopmental disorders including ASD. There is a significant association between exposure to mycotoxins and ASD as demonstrated in recent epidemiologic studies. These were recently reviewed in our publication of November 2020.[28] In addition, as mast cells are found perivascularly in all tissues, including the brain, recent publications have demonstrated convincing evidence linking the prevalence of mast cells and an increased risk for ASD.[29]

A study showed that in ASD, there is a 10-fold increase in children with mastocytosis as compared to the general population.[30] In addition, one third of patients with mastocytosis complain of neuropsychological symptoms such as fatigue, cognitive impairment, and depression. Mycotoxins can stimulate mast cells and microglia due to the mast cell-microglia interactions and these have been demonstrated to cause "brain fog" in neuropsychiatric disorders.[30-34] Even with all this, mold and mycotoxin disorders remain under the radar in adults and in children.

Once a clinician suspects that a patient, either an adult, child, or adolescent may be suffering from the effects of molds and mycotoxins, the next step is to order the most accurate type of testing for the patient. For molds, the immune system may already have immunoglobulin G (IgG) antibodies from a previous exposure, therefore it is non-specific. However, mycotoxins, which are toxins and therefore do not have cells walls, etc., the antibody response via IgG denotes a present condition as the immune system does not retain "in memory" IgG antibodies to toxins. One should not mistake the immune reaction in microbiology as the same as for an immune reaction in toxicology: they are different, as the first retains IgG antibodies for years and the second does not.

Antibody testing is highly precise, is directly to mycotoxins which is the antigen, and is not like the inaccurate urinary metabolites of mycotoxins, which can vary day to day and week to week, depending on diet, current medications, activities, and common metabolic changes, among others, and are not reproducible. Several studies have shown that mycotoxin antibodies can bind to human tissues, triggering autoimmunity. This is exceptionally important as a patient may present to a clinician with an autoimmune disorder caused by mycotoxins.[35-40]

Once it has been determined that the person or child indeed has tested positive for antibodies to mycotoxins, the next step is to apply the first rule of toxicology: get the toxin away from the patient or the patient away from the toxin. A patient cannot improve while still being exposed to molds and mycotoxins. Children are especially vulnerable as their brain and other organs are still developing.

Treatment is ultimately up to the clinician after assessing the patient. There are numerous studies that can be referred to depending on the symptoms, physical findings, and what diagnostically helpful ancillary studies can be ordered.[41] It is essential to refer to the peer reviewed medical literature and not the many unsubstantiated and unproven diagnostic and treatment methods found on the internet, most of which lack medical and scientific evidence and are not reproducible. These only serve to muddy the waters and does nothing to help those suffering from the effects of molds and mycotoxins, including children. It is also frequently used by traditional medicine practitioners to down-play and negate the diseases and disorders caused by molds and mycotoxins.

In conclusion, it is imperative to educate clinicians, especially those in primary care, to the deleterious effects of molds and mycotoxins in patients, and especially children.

The medical literature is replete with the diseases that molds and mycotoxins can and do cause, and how to accurately diagnose and treat those affected.[4,8,18,25,28,35-39] The most effective way to educate all clinicians is by peer reviewed published studies rather than by unproven and irreproducible methods. (*Altern Ther Health Med*. 2021;27(1):8-10).

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