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House Dust Mites: Their Influence on Human Health and Management

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Mites are among the oldest of all terrestrial animals with fossils known from the early Devonian, nearly 400 million years ago 1 (Norton *et al*., 1988). Mites are ubiquitous in distribution and are reported to be present almost in all the habitats. A World Health Organization Report (2000) stated that each person has a right to a healthy indoor environment, including safe indoor air. It is estimated that people spent 90 percent of their time indoors', often at home. Therefore, breathing clean indoor air can have an important impact on health. People include infants, young children, the elderly who mostly live indoors, may be at a greater risk of developing health problems, or having problems made worse by indoor air pollutants.

In India, the rapid increase of human numbers combines with desperate poverty to deplete and polute local resource base on which the livelihood of present depends. Due to increasing facilities in homes, people spend majority of their time indoor, mostly in domestic environment where their health may be affected mostly by indoor air pollution. Dust accumulation is a natural phenomenon that is created by routine sweeping of room or making of bed. It has serious consequences for the human being and environment. Accumulation process is often accompanied by heterogeneous assemblage of a variety of products of plant and animal origin, an appreciable portion of which is Constituted by the house dust mites.

House dust mites are tiny creatures related to ticks, chiggers, and spiders that live in close and they are indoor allergens association with humans and cosmopolitan guest in human habitation. First to prove that a mite, *Dermatophagoides pteronyssinus*, from house dust was the major potential cause of causation of allergy in sensitive persons and not the house dust proper (victims). *Dermatophagoides farina* and mold as potential allergens from house dust. House dust to give positive cutaneous reactions in sensitive patients. House dust mites are of great medical importance as they are responsible for causing asthma, rhinitis, atopic dermatitis, conjunctivitis, eczema etc.

House dust mites are nearly cosmopolitan in distribution as they are associated with house dust and bird nests. The family Pyroglyphidae contains about 16 genera and 46 species. In the world 36 species of house dust mites have been reported, out of which 29 have been reported in India. The 3 major house dust mites worldwide are *Dermatophagoides farinae, Dermatophagoides pteronyssinus*, and *Euroglyphus maynei*(temperate), *Storage mite, Blomiatropicalis* (Echymyopodidae, tropical). House dust mites, *Dermatophagoides farinae* and *Dennatophagoides pteronyrsinus* are the two most common species that are found in house dust samples of India.

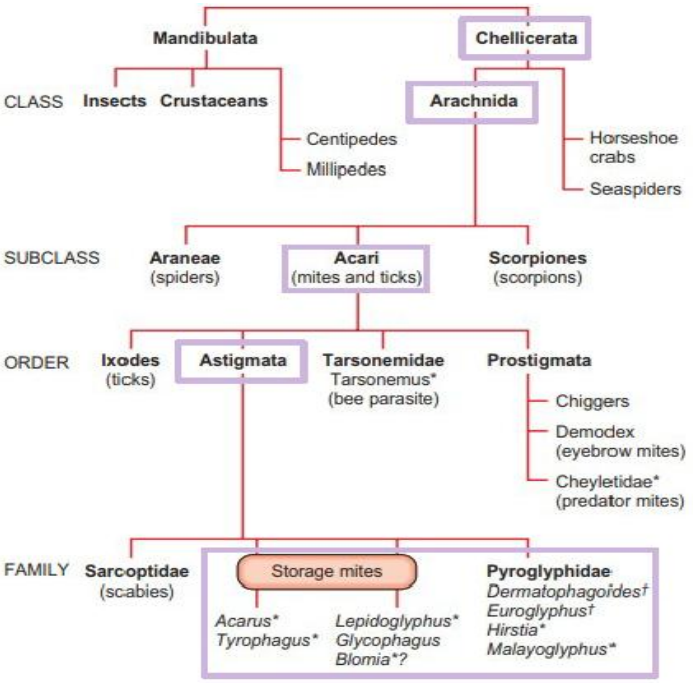

Fig 1. Taxonomy of house dust mite

Habit and Habitat of House dust mite

House dust mites prefer warm, moist surroundings such as the inside of a mattress, Carpet, and upholstered furniture or the places near the human rest provide suitable conditions for the presence of house dust mites in indoor household environment (Feng et al., 2009).

House dust mites are not parasites living on plants, animals and humans. House dust mites primarily live on dead skin cells, commonly called dander, which are shed regularly by humans and their animal pets in homes. The number of allergenic mites in the bed and floor dust of the patients is well correlated with intensity of the skin test reactions.

Morphological characters and Life cycle of house dust mite

Mites are poikilothermic minute sac like animals without body division. Adult mites are microscopic creamy blue and rectangle or oval in shape with translucent bodies, measuring 420 µm in length and 250-320 µm in width. Mouth parts produce a head like structure bearing a pair of chelicerae and a pair of padipalps. Four pair legs are found, Eyes and antenna are absent. The whole body bears long hairs and setae. Dust mites obtain water from the air by secreting a hyperosmotic solution from the tear shaped glands (supracoxal glands) that open just above the first pair of legs. Specialized "feet" allow the mite to maintain a strong, suction cup like grip.

The stages in the life cycle are the egg, a six-legged larva protonymph, eight-legged nymph stage tritonymph and adult male and females. The period of growth from egg to adult takes about 19 to 33 days. The adult mite life expectancy was 4-6 weeks and Lays 40-80 eggs.

House dust mite allergy in Human

Allergies are pathological manifestations originating from a trigger-sensitized immune system. Approximately 80% of house dust allergies are mite induced (Wharton, 1976). Dust mites is strongly associated with 3 diseases: asthma, perennial rhinitis, and atopic dermatitis. House dust mites, in particular *Dermatophagoides pteronyssinus* and *D. farinae* have been shown to play an important role in the parthenogenesis of asthma and atopic diseases. HDM is important "root cause" for the development of asthma in young children. Frequent exposure can lead to asthma, rhinitis, atopic dermatitis, sinusitis, urticaria, and conjunctivitis in susceptible individuals. In India, 250 million people are suffering from one or more allergic manifestations. and it is increasing day by day. Dermatophagoides, *Blomiatropicalis* is found common and abundant allergen responsible for asthma and rhinitis from house dust mite in some part of the world.

The mite's gut contains potent digestive enzymes that persist in their feces and induces allergic reactions in human beings. The mite's exoskeleton can also contribute to allergic reactions.

HDM Allergen

Enzymatic proteins present in mite debris or skin faeces in the form of dry pellets which deposit on skin by dust mites which makes allergy or irritation on human skin. Dust mite allergens are associated with particles that tend to have a large aerodynamic behavior, with most settling within 15 minutes of disturbance. Most house dust mite allergens have molecular weights between 10–50 kDa. Mite allergen level of >2µg/gm of dust (100 miles per gram) is considered as risk level for sensitization and symptoms of asthma. For non-allergic children higher "threshold" of 20 µg/g.

HDM allergen activated immune system through two pathways:

1. The protease activity of group 1 allergen potentially impairs epithelial tight junctions.
2. Group 2 allergen mimics MD-2 which co activates the TLR 4 signaling pathway.

HDM allergen's role in the human immune response

Allergenic effects in HDM allergy is the combined effect of the adaptive and innate immune reactions that makes HDM allergens so powerful. Components that can activate the immune system include not only proteases and immunogenic epitopes but also the structural polysaccharide chitin from the exoskeleton, microbial adjuvant compounds, and ligands originating from mite-associated compounds.

Symptoms caused by house dust mite in Human being

Some of the important symptoms are Sneezing, Runny nose, Itchy, red or watery eyes, Nasal congestion, Itchy nose, roof of mouth or throat, Postnasal drip, Cough, Facial pressure and pain, Swollen, blue-colored skin under your eyes, frequent upward rubbing of the nose in a childrens and In adults, headaches, fatigue, and depression.

Diseases in Humans

Allergic rhinitis

Allergic rhinitis is a symptomatic disorder of the nose that is induced after allergen exposure and caused by immunoglobulin E (IgE) mediated inflammation of the membrane lining of the nose. The inflammatory condition of the nose characterised by nasal obstruction, sneezing, itching, or rhinorrhoea, occurring for an hour or more on most days throughout the year. In the more severe cases there is also itching, burning and watering of the eyes

Atopic dermatitis (eczema)

Atopic dermatitis (AD) is a chronic, relapsing and pruritic inflammatory skin disease that is universally recognized in humans and in majority of cases are associated with type 1 hypersensitivity reactions to environmental allergens. It is condition that makes your skin red and itchy. It is long lasting (chronic) and tends to flare periodically. It may be

accompanied by asthma or hay fever. In adults, affects the back of the neck, the elbow creases, and the backs of the knees.

Asthma

The syndrome characterized by recurrent attacks of breathlessness due to reversible and wide-spread narrowing of bronchi in both the lungs. A condition in which a person's airways become inflamed, narrow and swell and produce extra mucus, which makes it difficult to breathe. Inhalations of dust mite allergens by hypersensitive individuals can result in acute attacks of bronchial asthma, accompanied by bouts of wheezing, shortness of breath, and perhaps even death.

Chronic urticaria

Chronic urticaria is defined as daily or almost daily occurrence of urticarial wheals for at least six weeks. Urticaria, is a kind of skin rash with red, raised, itch bumps. Appear anywhere on the body, painful swelling (angioedema) of the lips, eyelids and inside the throat.

Diagnosis of HDM allergy: Diagnosis of HDM allergy is usually carried out by history, eosinophilic count, skin prick test, and total and specific HDM serum immunoglobulin (Ig)E detection.

Management

3 ways to reduce house dust mite and their allergens are

- Avoidance
- Pharmacotherapy
- Specific immunotherapy

Avoidance

Avoidance of HDM and their allergens is widely recommended to diminish the severity of allergic rhinitis or allergic asthma symptoms in susceptible individuals.

Reduce temperature and humidity

Every morning you leave your bedding exposed to the sun or air so as to reduce the growth of the dust mites. Lower the relative humidity to less than 45%, which will slow down mite development. Usage of an HEPA (high-efficiency particulate absorption), De-Humidifier is recommended. Mechanical heat recovery ventilation (MHRV) with high efficiency vacuum cleaning. Increasing ventilation (Codina et al., 2003).

Physical method: Encasement of bedding, Washing, drying, and dry cleaning of bedding materials, Replacing carpets, draperies, and upholstery, Vacuums cleaner, Floor coverings, Laundry, Air filtration

Chemical method: Acaricides

Use of chemicals indoors relates to their safety, the efficacy of the active ingredient, and the formulation of the product. Benzyl benzoate, disodium octaboratetetrahydrate, tri-n-butyl maleate, sumethrin, and permethrin, and denaturants (tannic acid) have shown that a good active compound. 1% or 3% tannic acid, method of denaturing mite allergens also recommended. Herbs specially seeds of kranj, caster and neem is also utilized as extract in controlling these harmful dust mites (Khatri *et al,* 2011).

Pharmacotherapy

Hypo sensitization using vaccines also plays a role in treatment of allergy.

- **Antihistamines**: These drugs relieve itching, sneezing and runny nose. antihistamine tablets, such as fexofenadine (Allegra Allergy), loratadine (Alavert, Claritin,), cetirizine (Zyrtec) and taken as a nasal spray include azelastine (Astelin, Astepro) and olopatadine (Patanase).
- **Corticosteroids**: Nasal spray can reduce inflammation and control symptoms of hay fever. These drugs include fluticasone propionate (Flonase Allergy Relief), mometasonefuroate (Nasonex), triamcinolone (Nasacort Allergy 24HR), ciclesonide (Omnaris) and others.
- **Decongestants**: It shrinks swollen tissues in your nasal passages and make it easier to breathe through your nose. Some over-the-counter allergy tablets combine an antihistamine with a decongestant.
- **Leukotriene modifiers:** Montelukast (Singulair), which comes in tablet form.

Immunotherapy: Repeated administration of specific allergens to the allergic patient to develop immunological tolerance to the allergens and thereby reducing symptoms later to the allergen Exposure. Sublingual immunotherapy (SLIT) is a way to treat dust mite allergies without injections. SLIT tablets that treat dust mite allergy were approved by the FDA in 2017.

Conclusion

In India there is less fluctuation in environmental or indoor allergens, so that dust mites and their allergic disease phenotypes tend to be perennial rather than seasonal. Nowadays, various extramural mites have been shifted to intramural

environment and cause allergy. Though house dust mites are small, these have a huge impact on society. Still rural households are unaware about the house dust mite problems that they are facing due to illiteracy, ignorance, lack of exposure to mass media and unawareness. A large percentage of the population has been affected by them; hence multiple industries have developed to produce wide varieties of products for cleaning, dust protection, treatment and reduction of dust mites thus, to reduce the number of people that suffer from symptoms associated with dust mites.

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