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House dust mites: A harmful indoor dust pollutant

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INTRODUCTION

It has been said about house dust mites that "if you knew how harmful common dust could be, you would be walking around masked all day". United States Environmental Protection Agency defines house dust as a complex mixture of biologically derived particulate material (animal dander, fungal spores etc.), deposited from the indoor aerosols and soil particles brought in by foot traffic. Dust particle size is of particular importance as it influences the accumulation and resuspension of dust in the indoor environment (Morawska and Salthammer, 2003). The accumulation of dust is readily influenced by airflow patterns and activities taking place in the area (Thatcher and Largton, 1995).

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 (Lakhmi and Haq, 1999). These are indeed normal co-inhabitants of man's nest. A dirty house can make a house dust allergy problem worse. However, normal housekeeping procedures may not be enough to get rid of house dust allergy symptoms. This is because many of the substances in dust cannot be removed by normal cleaning procedures. For example, no matter how vigorously one can dust or vacuum, one will not reduce the number of dust mites present deep within carpeting, pillows and mattresses. Vigorous cleaning methods can put more dust into the air, making symptoms worse.

Unlike some other kind of mites, 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 (Barbogg, 2003). A number of species of house dust mites have been found throughout the world. Dermatophagoides farinae and Dermatophagoides pteronyrsinus are the two most common species that are found in house dust samples of

India (Lakhmi and Haq, 1999).

House dust mites prosper in houses or areas where there is high humidity and lower light intensity (Hart *et al.,* 1998). Carpet, mattress and upholstered furniture or the places near the human rest provide suitable conditions for the presence of house dust mites in indoor household environment (DeBoer and Kuller, 1994 and Nadachatram, 2005). House dust mites thrive in the environment provided by beds, kitchens and homes in general, where the sun rays do not reach them (Mahamic and Tovey, 1998; Warner, 1999; Fernandez and Caldas, 2002 and David, 2007). The bed is the most intimate human environment and serves as the focus of infestation, because the common house dust mites feed on human dander, which is shed mostly in the bed.

Dust mites are found in high concentration in pillows, mattresses, carpeting and upholstered furniture. They remain in mattresses, carpets, furniture and bedding, since they can climb lower down through the fabric to avoid sun, vacuum cleaners, and other hazards and climb higher upto the surface where humidity is high to get another skin cell to feed on. Even in dry climates, dust mites survive and reproduce easily in bedding, especially in pillows because of the humidity generated by the human body during breathing and perspiring. Human beings are important carriers of dust mites from one place to another through their bodies and clothing (De Lucca *et al.*, 2000). Bathrooms and kitchen are also important places that create a higher concentration of house dust mite allergen in houses; due to pets; the severity of allergy increases many folds (Modak and Saha, 2002 and Reinero *et al.*, 2007).

Interestingly, in Indian environment house dust mites are uniquely fitted for a life in dry environment as well as seasons of higher humidity and can survive without problem for long period. The reason behind this is that the mites have means for extracting moisture directly from air. They can survive in a temperature of 20-45º C and between 40–55 per cent relative humidity (Denis and Vervolet, 1990).

Health risks from HDMs :

Dust mites have been widely viewed as the most important source of indoor allergens in house dust by Institute of Medise, Washington (Salvatore, 2001). These are also known as the biggest "culprits" in home. Unlike other common household bugs-fleas for example – dust mites, do not bite. Their bodies, secretions and faeces contain particular proteins that can trigger allergic symptoms in susceptible people (Munir *et al.*, 1998). According to an ENT consultant Rakesh Singh (2008) Delhi, "In India, problems associated with dust allergies are on the rise, especially with changes in home decor trends that tend to focus on the increasing use of fitted carpets, soft furnishings, and inadequate ventilation."

Allergic asthma is a worldwide problem of considerable clinical importance. Links between asthma and exposure to house dust mites have been recognized for more than 300 years. Estimates are that dust mites may be a factor in 50 to 80 per cent asthmatics. Many research studies reported a strong association between house dust mite exposure and asthma symptoms. In centers where the indoor house dust mite exposure was also high, the prevalence of asthma was also higher (Marks, 1995) mentioned some of the symptoms and complications due to house dust mites. These are as follows (Table 1).

House dust mites are the major cause of year round complaints of stuffy nose, sneezing and watery eyes what some people describe as a 'permanent cold'. However there are reports of red rashes around the neck. Other allergic reactions may include headaches, fatigue and depression (Arlian *et al.*, 2002 and Bharadwaj, 2008).

Table 1 : Symptoms and complications from house dust mites

Sr. No.	Symptoms	Complications
1.	Wheezing	Frequent ear infection (otitis media) in children
2.	Coughing	Drowsiness and other side effects of anti- histamines
3.	Breathlessness	Sinusitis and / or nasal polyps
4.	Tight feeling in the chest	Anaphylaxis (a rare but severe allergic reaction)
5.	Running nose, itchy nose,	Disruption of life cycle
6.	Itchy eyes,	Children may breathe through the mouth instead of nose with resultant facial changes
7.	Itchy skin, skin rashes	Hives or other skin rashes
8.	Headache, fatigue and depression	

Household indoor environment and house dust mites:

Improper ventilation, unhygienic and insanitary conditions causes dust accumulation which results in the occurrence of micro-organism called HDMs. They have been recognized as the most highly allergenic contaminants found in indoor environment in house dust, often heavily contaminated with the fecal pellets and skins of house dust mites. Modern furnishings and furniture like carpets, sofa, mattress, upholstered furniture and bookshelves serve as reservoirs of these indoor allergens harmful for human beings.

Ehrler *et al*. (2000) highlighted that the bed represents the most important allergen source for house dust mite-allergic patients. So these patients should protect themselves, especially in bed, from mite allergen-loaded particles. This can be done through the use of several encasings. Particles released from or through the mattress have been detected and characterized. Additionally the encasings have been washed three times. These encasings are, therefore, very useful for people with a house-dust mite allergy. Along with the encasings of mattress, Rijissenbeek *et al.* (2003) in Switzerland highlighted on the encasings of pillow and duvets. It was suggested that anti allergic mattress covers may have an additional effect on patient's well being and may prevent further deterioration of the disease. To compare mite allergen levels in carpeted sleeping accommodation in private dwellings and public places (Mamoon *et al.*, 2002) in Australia measured the allergen in mattresses and bedroom floors in homes, hotels and child care centers and a university hall of residence. Indoor temperature and relative humidity were also measured. Data was collected about the age of the building, age of the carpet, method and frequency of cleaning, frequency of room use and use of air-conditioning. Lower house dust mite allergen levels of carpeted sleeping accommodation were found in public places than private houses.

Sidenius *et al.* (2002) pointed out that the knowledge of the occurrence of house dust mites (HDM) and their allergens in domestic locations is important in planning intervention. The aim of this study was to describe the distribution of HDMs and their allergens before intervention in multiple locations in the homes of newly diagnosed HDM-allergic patients with a known high concentration in their mattress dust. Dust was collected from ten locations in the homes of eight HDM-allergic patients. Dust was analyzed for allergen content with ELISA technique and HDM were counted. From this HDM intervention, results indicated that priority should be given to the removal of allergens from mattresses and in addition from carpets, duvets/pillows and upholstered furniture. Dust from walls, uncarpeted floors, book shelves and curtains appear to contribute insignificantly to the domestic HDM allergen load.

Maas *et al.* (2003) in Netherlands investigated the distribution of house dust mite allergen (Derp1) in living rooms with smooth floor coverings, as measured in the middle compared with the border of the floor. It was hypothesized that activity causes displacement of (Derp1), from the middle towards the border. In results it was showed that border samples contained significantly more house dust mites compared with middle samples. Presence of pets and presence of more than two inhabitants increased the difference. It was concluded that the house dust mites were unequally distributed on living room floors with smooth coverings, most likely because of displacement of dust from the middle towards the border due to activity. House dust mites have been considered the most important source of allergens for humans. These allergens have been encountered at different indoor sites, mainly on mattresses and pillows. Oliveira *et al.* (2003) evaluated the number and different specimens of mites on Brazilian bunk-bed mattresses. A study was done by Cho *et al.* (2006) on the effect of home characteristics on house dust mite antigen concentrations and loads in homes Cincinnati, Ohio. Various home characteristics which were investigated in indoor were dampness in the home, use of dehumidifier, central forced air heating system, having indoor plants and presence of carpeted floor. Antigen levels (concentrations in micro gram) in floor dust samples collected in child's primary activity room were analyzed by ELISA technique. The relationship between the antigen levels and home characteristics was investigated through a generalized multiple regression models. More than half of the homes experienced water damage and HDMs. High level of house dust mite allergen was measured in bedrooms and in homes using dehumidifier and no central forced air heating system. Having indoor plants was shown to reduce allergen levels. Carpeted floor was found to hold larger amount of antigens than non-carpeted floor.

To asses present situation of house dust mites in

Dakahlia Governorate, Egypt by El-Shazly *et al.* (2006). The population densities of different live adult mites were investigated in terms of species abundance, site distribution (in houses) and seasonal variation. Houses in the urban and rural areas were sampled. Mites were most predominant in bedrooms as compare to living rooms and kitchens. Similar predominance was found in rural houses. Results revealed that all the dust mite species had two peaks of abundance, the first in spring (higher peak abundance) and the second in autumn.

Factors affecting the growth of house dust mites :

House dust mites are widely viewed as the most important allergen in the household dust. HDMs concentration is influenced by many factors including occupant behaviour too. Presence of House dust mites in home dependents upon many factors, which may either increase or decrease their growth. The most important limiting factor for house-dust mite populations is air humidity (Bronswijk *et al.*, 1991; Fletcher *et al.*, 1996; Boer *et al.*, 1998 and Hart *et al.*, 1998).

Korsgaard (1998) in a study on epidemiology of house dust mites in Danish reported that clear association was found between indoor air humidity and increased occurrence of house dust mites in house dust. In temperate climates, there is a threshold level of indoor air humidity of (45%) relative humidity at usual indoor air temperature). Indoor air humidity below this level for extended period will eradicate house dust mites from dwellings.Studying mite sensitization in the Scandinavian countries and factors influencing exposure level, Munir *et al.* (1998) documented that sensitization to mites among children particularly Sweden is increasing. Poor indoor climate, e.g. high humidity and poor ventilation as a consequence of energy saving measures, are cited as a possible explanation of this increase. Modern furnishings such as carpets and various kinds of upholstery, may also serve as reservoirs of indoor allergens.

Corsage (1999) evaluated the effect of preventive measures on the concentration of house dust mites in USA. In urban areas mites were more predominant in bedrooms than other living areas and highest in spring season. Although the patients' homes were cleaned more frequently and greater concentrations of house dust mites were found in dust from bedrooms carpets in the patients' homes as compared to control subjects. Thus, it was concluded that high humidity improves the survival of house dust mites in homes.

Warner *et al.* (1999) studied the mite fauna in homes of Sweden. In the houses dust samples were collected from four locations of the home namely bedroom, living room, kitchen and bathroom. In each location different type of objects, which may contain HDMs, were selected for dust sampling by vacuum machine. ELISA technique was used for the determination of HDMs. Mite density was increased in homes with high humidity and was found higher in bungalows than in flats.

Crowther *et al.* (2001) studied house dust mites and the building environment and highlighted various types of factors which enabled them to occupy in different niches at home. Mattresses are generally considered the main living and breeding ground for HDMs since they provide ideal environmental conditions and plentiful supply of food, but this is not always the case. Arlian *et al.* (1982) found a living room carpet in Ohio, which support a population of HDMs, seven times larger than that found in the mattress. The thickness of mattress may also be a factor. However, it was noted that higher number of HDMs were present in homes over 10 years old compared with younger houses. Differences between mite numbers in mattress and carpets may be related to their age, but they will also be influenced by a number of other factors such as room temperature, humidity, vacuuming and type of mattress or carpet. Other soft furnishings may also support HDMs. Mitchell *et al.* (1969) found that mite density was greater in frequently used furniture than pieces rarely used. This is likely to be due to the greater number of skin scales supplying food for HDMs and higher moisture content of furniture which is used regularly.

A study was carried on the effect of certain socio – ecological factors on the population density of house dust mites in mattress dust of asthmatic patients of Calcutta by Modak and Saha (2002). It was stated that allergy to house dust mites was fairly a common problem in Calcutta and its adjoining areas since last two decades. Frequency of cleaning has also found a significant role in reducing the mite population.

Rae *et al.* (2002) aimed to quantify the levels of HDMS in different university student accommodation in Dunedin (New Zealand) and assessed the relationships with housing characteristics and housekeeping practices. Many of the students live in newer-style but often ill

ventilated flats. Furnishings, curtains and carpets are generally old and/ or dusty in these flats. Students living in the close confines of the halls of residences have no choices in the types of bedding or flooring used or the frequency of bed linen changes, and may not have access to a vacuum cleaner. The results of the study showed that bed and floor HDMs levels were influenced by different environmental factors. HDMs level in bed was associated with duration of residence in the studied dwelling. Custovic *et al.* (1996) also reported convergent finding that higher levels of HDMs were found in mattress having greater than one year of age. Hence, it was concluded that mattress can become a significant source of exposure to mite allergens after as little as four months, with allergen levels generally stabilizing after one year.

An effort was done by Bency *et al.* (2003) to assess the indoor air quality and its consequences on the households of Thiruvananthapuram city of Kerala. Three zones namely residential, industrial and commercial were selected for the study. It was emphasized that, many recent policy interventions in India have been undertaken to improve ambient air quality but very little is known about indoor air quality (IAQ), which is directly correlated with the indoor environment and house dust mite diseases. Congested houses in the commercial zone lead less air circulation causing dust to accumulation. Many of the respondents were reported allergic from HDMs problems. In residential zone, improper household garbage disposal and insanitary conditions were the major reasons of HDMs problems.

Hesselmar *et al.* (2005) assessed the possible relationships among allergen levels in house dust, characteristics of residence buildings and allergic diseases in children. Dust samples for analysis of house dust mites (Dermatophagoides farinae and Dermatophagoides pteronyssinus) allergens were collected from children's beds, and living room. A strong association was found between HDM-infestation and wheeze. The type of building (houses when compared with flats), ventilation system and presence of a basement had all major implications on respiratory symptoms and HDM infestation. Association was also observed between HDM infestation and indoor environment. Building construction had a causative relationship with disease development.

Silva *et al.* (2005) investigated the mite fauna in dust samples from mattresses of cribs and beds in Londrina, Parana, Brazil. It was found that mattresses have sufficient mite bodies to cause sensitization to humans. The use of mattress covers for cribs and beds should be encouraged to avoid allergen exposure.

A study was done by Causer *et al.* (2006) in New Zealand on the effect of floor covering construction on content and vertical distribution of house dust mite allergen. The results showed significantly lower amounts of Dermatophagoides pteronyssinus (HDMs) were found on hard flooring than any of the carpets, which all contained similar amounts of mite allergen.

Marin *et al.* (2006) studied on the house dust mites in mattresses of Martinique. Objective of the study was to identify the various house dust mite (HDM) species colonizing mattresses and to determine the differences according to the characteristics of the mattress and housing. All the mattresses contained HDMs. Shah and Bapat (2006) assessed the effect of window air conditioning at home on occurrence of house dust allergy by HDM infestation in Mumbai women. Higher percentage women from air-conditioned homes versus non-air-conditioned homes were suffering from house dust allergy. Air-conditioned homes were found major risk factor for HDM infestation.

Textile floor coverings (TFC) are an important element of equipment in homes and public buildings are regarded as a settlement of HDMs and thus, the cause of the settlements of house dust mites, which are the major cause of mite-induced allergy. So an effort was made by Cieslak *et al.* (2007) in Poland to evaluate the effect of modified TFC on house dust mites. The culture of HDM was used to test properties through the addition of biologically active agents to the coated backing and mounting the same acaricides and anti-adhesive fluorocarbon dispersion of pile fibres. The result of the study showed that the modified TFCs are characterized by anti-dust mite properties that protect against house dust mites.

Hence, the most limiting factors for HDMs growth are relative humidity and temperature. House dust mites in home are dependent on so many other factors, which may either increase or decrease their growth. Various socio- ecological management practices like the age of house, structure and material of the houses, type of building, pattern of house cleaning and even the economic status of the respondents have had an impact

on the growth of HDMs.

Management of HDMs :

Several studies (Patil *et al.*, 2001; Singh and Rao, 2001 and Khatri, 2006) highlighted that homemakers do not have knowledge about house dust mites though they are aware of health hazards caused due to dust. Constant exposure to mite allergens can lead to chronic illnesses. High exposure to dust mites in infancy has been implicated as a cause of increasing prevalence of asthmatically predisposed allergies - atopics (Drees and Jackman, 1999). For the control of house dust mites varied physical and chemical measures like vacuum cleaner, disinfectants, jells, sprays, dehumidifier etc. are now available in the market. But due to high costs and many side effects these are not commonly used by the lay public. Hence, people due to ignorance of the symptoms and complications caused by HDM pay no attention to these measures. Three acaricides or pesticides have been used against HDMs, which are Paragerm, benzyl benzoate and pirimiphos methyl. But the formulation of safe and effective chemical control agents is however, said to be complex and requires expert pharmacological advice (Nadchatram, 2005).

Various researches on household disinfectants stated different health risks that include genetic damage, cancer potential, nurotoxic damage to unborn children. The common chemical, which is used in household disinfectant, is malathion (presently banned) which has shown to have serious health effects on humans (Kawasaki and Kawasaki, 1999; Nickmilder *et al.*, 2007 and Rembold, 2007). Observed effects include weakening of immune system thereby resulting in increased colds, flu and infection, birth defects, genetic damage, accelerated aging of certain body organs, increased neurological damage to the elderly and serious harm to wildlife too (Pressinger, 2007).

In the oral traditions, local communities in every ecosystem from the Trans Himalayas down to the coastal plains have discovered the medical uses of thousands of plants found locally in their ecosystem. India has one of the richest plant medical cultures in the world. It is a culture that is of tremendous contemporary relevance because it can on one hand ensure health security to millions of people and on the other hand it can provide new and safe herbal drugs to the entire world. There are numerous species of plants that are reputed to be efficacious in the practice of herbal medicine in India. These plants are non-conventional and found locally in abundance, easily available and cost effective too. These plants are effective in controlling micro-organisms and have no side effect on human health. The importance of non-conventional partially purified plant product components for the control or management of diseases is being actively pursued by various investigators in India. Khatri (2011) conducted a study in Udaipur city of Rajasthan. For the management of house dust mites, herbal measures were used. All the plants used were nonconventional. These are locally available and also found in abundance. The plants extracts were used for making non conventional plant product components (NCPPC). The results after application of NCPPCs revealed satyanashi PPC significantly superior in terms of HDMs mortality rate followed by castor PPC and sahjan PPC in indoor environment.

Conclusion:

Presence of house dust mites is a matter of serious concern. Improper house cleaning accumulates dust in indoors furnishings and furniture which creates unhygienic and insanitary conditions in house. Dust mites live in settle dust that causes severe health problems for inmates. This hazard becomes all the more grave in localities which are not properly designed and are bereft of modern amenities. Insensitivity to ecological concerns aggravates the problem. Lack of awareness amongst home makers about the factors that lead to generation and endurance of HDMs renders the challenge of getting rid of them more onerous. Any excessive use of disinfectant (chemicals) may and do have grave side effects for the human beings. It is, therefore, of critical significance that herbal measures are investigated which have the powerful efficacy to kill the HDMs without causing any deleterious impact on human health.

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