



Preventive measures to avoid contact with house dust mites and their allergens

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ABSTRACT: House dust mites (HDMs) of the genera *Dermatophagoides* and *Euroglyphus* are the most important allergens in human habitations to which ca. 7% of the human population in developed countries become allergic. The allergens are excreted through their faeces and the control of mites and the elimination of the produced allergens could alleviate and allergic symptoms. For this purpose, the relative humidity should be kept below 50% at home, as higher humidity enhances the development of HDMs. The biggest attention should be given to the bedroom, and especially to the bed. Mattresses, upholstered furniture, and heavy carpets are the most important biotopes of HDMs and should be regularly vacuumed, treated with acaricides and/or exposed to sunlight. Allergen-tight sheets and pillow covers which do not permit the allergens existing on the mattress or pillows to come in direct contact with the patient should be used. Sheets, blankets, pillowcases and bedcovers should be washed every 2-3 weeks at 60°C and above. Heat will kill dust mites and neutralize a large part of the allergens. The floor should be fitted with tiles, wood, linoleum or vinyl material, and not with wall-to-wall carpets. Heavy carpets, especially those made from wool should be removed from the bedroom. Any object which is not being used on a regular basis and could collect dust, should be removed, washed regularly or kept in allergen-tight plastic bags. In conclusion, mite and allergen avoidance could alleviate the allergic symptoms of HDM allergic individuals and reduce the medication taken to treat such symptoms.

Keywords: House dust mites, *Dermatophagoides*, *Euroglyphus*, prevention, control.

INTRODUCTION

House dust mites (HDMs) are the leading allergens to which patients with dust allergy are most susceptible. *Dermatophagoides pteronyssinus* (Fig. 1), *Dermatophagoides farinae* (Fig. 2) and *Euroglyphus maynei* (Fig. 3) are the most common mites of the house dust mite fauna worldwide (Platts-Mills et al., 1989).

HDMs are usually found in every household (both allergic and non-allergic), and thousands of HDMs can be found in one gram of house dust collected from the main biotopes of the mites such as mattresses, carpets and upholstered furniture. Their allergens, largely constituted by proteins such as Der p 1 and Der f 1, are excreted through their faeces to the environment, which later are decomposed and become airborne (Arlian, 1991; Arlian et al., 2002; Miller, 2019). The allergens are inhaled by all inhabitants but only those who are allergic develop clinical symptoms (Tovey et al., 1981; Arslan et al., 2019).

Although HDMs are present throughout the year inside human habitations, their number increases particularly during the summer months. The allergens which accumulate during these months decompose and become airborne during the following months. HDM allergic patients complain of dust allergies especially during the autumn months when in addition to HDM allergens, temperature differences inside and outside habitations and the presence of viruses, render the upper respiratory airways more sensitive. The perennial symptoms usually start in

childhood ages and can continue into adulthood. HDM exposure in infancy was associated with an increased risk of specific sensitization at 4 years of age (Brussee et al., 2005; Casas et al., 2015; Rubner et al., 2017). A level of 2 µg of Der p 1/g dust, which is equivalent to 100 HDMs is considered as a risk factor for sensitization, while 500 mites/g dust are capable of causing allergic reactions in sensitized patients (International Workshop Report, 1988; Platts-Mills et al., 1989).

Only medication can help when the patient's allergic symptoms begin. For the therapy of symptoms decongestants to help dry up the air passages, antihistamines, nasal steroids, leukotriene inhibitors, and immunotherapy are being used (Pichler et al., 1997; Mener and Lin, 2015; Nelson, 2018).

In developed countries, approximately 30% of the population suffers from one or more allergic disorders, while ca. 7% being allergic to HDM. In such patients HDM avoidance is logical, but there is considerable uncertainty regarding the efficacy and effectiveness of interventions designed to reduce dust mite exposure. While HDM allergen avoidance did not show any effect on the allergic symptoms in some studies, other studies showed a positive effect on patients with asthma, eczema and allergic rhinitis (Demir et al., 2018). In seven of the nine intervention trials, when compared with control, the interventions significantly reduced the HDM load. Acaricides appeared to be the most promising type of intervention; however,

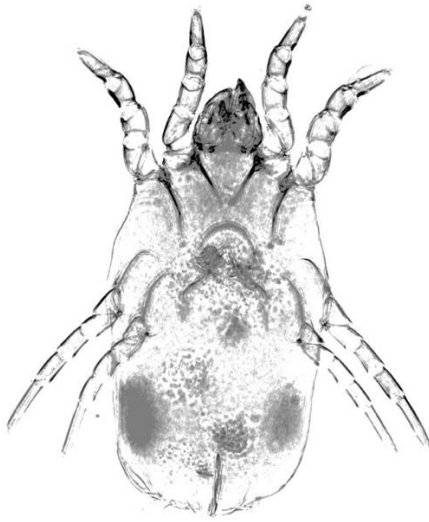


Figure 1. *Dermatophagoides pteronyssinus* (female)



Figure 2. *Dermatophagoides farinae* (male)



Figure 3. *Euroglyphus maynei* (female)

these results should be interpreted carefully due to methodological limitations. Isolated interventions such as the use of impermeable mattress covers offered little clinical benefits (Platts-Mills et al., 1989, 1997; Colloff et al., 1992; Calderon et al., 2015; Singh and Hays, 2016; Miller, 2019).

The aim of this review is to summarize the preventive methods which could be used to reduce the amount of HDMs and the allergens they produce inside the house in order to minimize the exposure and alleviate the allergic symptoms which are related to mites.

Morphology and Taxonomy

HDMs of the genera *Dermatophagoides* and *Euroglyphus* belong to the subclass Acari, the order Sarcoptiformes, the cohort Astigmatina and the family Pyroglyphidae (Krantz and Walter, 2009). From the egg hatches the larval stage, which later develops to protonymph, tritonymph and adult mites. They are whitish in colour and their body is translucent. The size of the adults varies between 250-350 μm (Colloff, 1998; Miller, 2019).

Biology and Epidemiology

HDMs are free-living organisms that have chosen house dust as biotope. Their life-cycle last for about a month and the females which live up to 100 days lay about 300 eggs. They are feeding on human and animal dandruff and the microorganisms such as bacteria and fungi which grow on them (Colloff, 1991; Arlian and Morgan, 2003; Miller, 2019).

The most suitable temperatures for their development are 25-26°C and they thrive best at relative humidity (RH) around 75% (Colloff, 1987). Since the average temperature inside houses is around 23-25°C throughout the year, humidity is the most important factor for their reproduction. Moisture is high when the house is located in the vicinity of seas, lakes and forests; inside the house large quantities of moisture is produced in the kitchen and bathrooms; while the sleeping persons increases the humidity on the bedding and mattress by sweating during the night. In addition, HDMs can absorb moisture from the environment through their cuticles. When the RH decreases below 40%, their number decreases due to dehydration (Arlian, 1992). Accordingly, people living in areas with high moisture have more HDM in their house than those living in dry areas, e.g., deserts. Few mites were found in human habitations in dry areas while in humid areas over 10,000 mites per gram dust were isolated (Mumcuoglu, 1975; Mumcuoglu et al., 1999). A positive correlation was found between the number of mites and the moisture content in the dust collected from different geo-climatic regions of Israel (Mumcuoglu et al., 1999). A positive correlation was also found between the number of HDMs and the altitude of the houses that were examined. In higher altitudes where the climate is usually cold, houses are heated for longer periods and accordingly the relative humidity inside the habitations is low (Mumcuoglu, 1975; Charpin et al., 1991).

Dust mites are quite rare in frequently cleaned hospitals and hotels, where the bedding is also regularly changed.

Pets such as cats and dogs are also shedding dandruff and could be considered as additional source of dandruff inside the house and HDM were found in their sleeping places, creating additional biotopes for HDMs inside the houses (Mumcuoglu, 1975).

Allergens produced by HDMs in their biotopes can easily become airborne and distributed in all parts of the house, especially in objects which easily accumulate dust and which are rarely cleaned such as libraries, curtains, large lamps and toys (Mumcuoglu, 1975; Mumcuoglu et al., 1999).

Prevention and Control

The biggest attention should be given to the bedroom, where the allergic patient spent third of his day and it is in close contact with mites and allergens existing on the bed, as well as to the living room, where the patient spends several hours of day while watching television, playing, reading, resting, and having guests. If possible, the bedroom of the allergic patient should be on the side of the house with the highest exposure to sunlight. The bedroom should be ventilated regularly, especially on sunny and dry hours of the day. The relative humidity should be kept below 50% at home, and a dehumidifier or air conditioner could be used for this purpose. It should be kept in mind that dust is capable in absorbing humidity from the environment and in the different layers of the dust the conditions could be optimal for the development of mites. It is thought that the increase of dust mite allergies in the USA is caused by the airtight construction of houses for energy saving purposes, which has however the disadvantage that it does not allow the ventilation of the rooms and the lowering of humidity (for review see International Workshop Report, 1988; Arlian, 1991, 1992; Colloff et al., 1992; Marks et al., 1995; Platts-Mills et al., 1997; Perry et al., 2006; Sheikh et al., 2010; Mener and Lin, 2015; Bremner and Simpson, 2015; Narkervis et al., 2015; Sánchez-Borges et al., 2017; Wilson and Platts-Mills, 2018).

The floor should be fitted with tiles, wood, linoleum or vinyl material, which is easier to clean and does not collect dust. Such floors should be cleaned with a damp rag, while dry dusting should be avoided.

Mattresses are one of the most important biotopes for HDMs. As they do usually not look dirty, they are not cleaned regularly, resulting in the accumulation of - that is not visible to the eye - layers of dust, especially around the buttons, stitching and the elevated edges of the mattress. Therefore, they should be vacuumed at least once a month and where possible both sides of the mattress should be exposed to direct sunlight. Mattresses with a flat surface, i.e., without buttons, stitches, and border lines should be used, which allow minimum possibilities for the dust to accumulate and are easier to vacuum cleaning. There are allergen-tight sheets and pillow covers which do not permit the allergens existing on the mattresses and pillows to come in direct contact with the sleeping patient (Arroyave et al., 2014).

Sheets, blankets, pillowcases and bedcovers should be washed every 2-3 weeks at 60°C and above. Heat will kill dust mites and neutralize a large part of the allergens. In general, synthetic bedding instead of organic wool and feathered material should be used. Any components of bedding which are not being used and are kept in draws under the bed should be either removed or kept in allergen-tight bags (Colloff, 1987).

Heavy carpets, especially those made from wool should be removed from the bedroom. Carpets with long fibers are important biotopes of HDMs, where dust is accumulated in the lower levels of the fiber. If not removed, carpets should be vacuumed regularly and/or exposed to sunlight. Powerful vacuum cleaners such as High Efficiency Particulate Air filtered (HEPA) ones could eliminate large quantities of dust, while the less powerful ones remove only the superficial dirt, giving the impression that the carpet is clean (Yu et al., 2009). Wall-to-wall carpets, which render the entire room to a biotope for HDMs, should be avoided (Perry et al., 2006).

Upholstered furniture on which the inhabitants spent many hours of the day, e.g., while watching television, resting or having guests, and on which the RH and temperature is higher due to the body temperature and humidity, should be vacuumed regularly while paying attention to the hidden places of the furniture, and/or should be exposed to sunlight. When replacing upholstered furniture, leather, plastic or vinyl furniture should be preferred (International Workshop Report, 1988).

Any object which is not being used on a regular basis and could collect dust, such as tabletop ornaments, books, magazines, newspapers, stuffed animals, fabric toys, clothes, and bedding, should be removed, washed regularly or kept in allergen-tight plastic bags. Books should be kept in closed cupboards and clothing in drawers and closets. Winter clothes should be kept in plastic bags during the hot months of the year and the opposite should be done with summer clothes during the cold months. Heavy curtains should be replaced by light and washable one, while large lamps should be replaced by small ones.

Some chemical and non-chemical control methods for HDMs were suggested (Skelton et al., 2010; Edrees, 2014), but they are not established ones and there is not enough information about their effectiveness under field conditions.

General Remarks

It should be kept in mind that sleeping overnighting in another house such as those of friends and relatives, especially in those located in humid areas, might expose the patients to HDM allergens, even when large efforts are being done in his/her house in reducing the allergen quantities.

Although pet animals such as cats and dogs could be a direct source of allergies, they can increase the number of HDMs in the house by shedding dandruff and creating optimal conditions for the mite development in their sleeping places inside the human habitations.

Mattresses, upholstered furniture and carpets could be treated twice a year with permethrin containing acaricides, while the necessary precautions should be taken with those suffering from respiratory symptoms, and from children coming in contact soon after the treatment.

In poor and overcrowded conditions, mattresses are piled during the day in a corner of the room, and as they are not ventilated the humidity in such object could be very high, creating and optimal conditions for a quick development of HDMs.

HDM allergic people should stay out of the area being vacuumed while someone else does the work, and enter the room ca. two hours after the cleaning process. If the allergic person has to do himself the vacuuming, he/she should wear a mask to minimize the exposure to allergens, which might become airborne during vacuuming. It would be advantageous to use double sealed or HEPA-filtered vacuum cleaners.

Mites on non-washable items could also be eliminated by either freezing for 24 hours or by using high-temperature steam-cleaners. The former could kill mites, however will not eliminate the allergens.

Moving to a part of the country where the humidity and accordingly the number of HDMs is low could have a significant effect on the wellbeing of the patient.

CONCLUSIONS

Removing mites and their allergens is a complex and difficult task, and in most cases a single avoidance/treatment method will not give the desired results. Though it might be impossible to remove all mites and allergens from the patient's environment, it is however possible to decrease significantly their numbers and allergen quantities. By doing so, it is possible to decrease the number and severity of allergic attacks and to diminish the use of medications.

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