Journal of the Egyptian Society of Parasitology, Vol. 51, No. 3, December 2021
J. Egypt. Soc. Parasitol. (JESP), 51(3), 2021: 647 – 660
(Online: 2090-2549)

ALLERGENS, PUBLIC HEALTH RISKS, AVOIDANCE AND TREATMENT

By
TOSSON A. MORSY[1*], SAFIA GLAL SHARAF[2] and SUZAN ATTIA EL- SHAHAT[2]
Faculty of Medicine, Ain Shams University[1], Cairo 11566 and Military Medical Academy[2], Cairo, 11291, Egypt (*Correspondence: tossonmorsy@med.asu.edu.eg or morsyegypt2014@gmail.com Orcid.org/0000-0003-2799-2049

Abstract

An allergen is an agent that can cause an allergic reaction. In some populations, the immune system recognizes allergens as foreign or dangerous. Thus, the immune system reacts by making a type of antibody IgE to defend against allergen and lead to allergy symptoms. Domestic animals are one of the commonest allergen worldwide that children are sensitized. Commonest allergic agents include: 1- Animal proteins and animal dander, 2- Insect bites and stings (their venom), 3- Insect and mite feces, 4- Insecticides, pesticides and repellents, 5- Crustacean shellfish (e.g., crab, lobster, shrimp), 6- Pollen, 7- Drugs (such as antibiotics or medicines oral, injected, inhalation or on skin), 8- Foods (such as egg, peanut, milk, nuts, soy, fish, animal meat, and wheat), 9- Fungal spores, 10- Dust (especially house dust mites, & 11- Natural rubber latex.

Key words: Allergens, Causes, Signs, Symptoms, Prevention, Treatment, Overview

Introduction

Immediate hypersensitivity to allergens is commonest among children and youths with asthma and rhinitis (Platts-Mills *et al,* 1997). Sensitization to one or more of the major indoor allergens (such as dust mite, cat, dog, or cockroach), combined with significant accumulation of relevant allergens in house, was consistently found to be the strongest risk factor for asthma in population, case control, and prospective studies (Squillace *et al,* 1997). No doubt, certain indoor allergens, such as dust mite, are more important in pathogenesis of allergic airway disease than others, in active investigated areas (Platts-Mills, 2007). Burke *et al.* (2003) in USA reported that the asthma comprised a wide range of heterogeneous phenotypes with differrent presentation, etiology and pathophysiology, risk factors for each recognized phenotype of asthma include genetic, environmental and host factors. They added that although a common family history of asthma, but were neither sufficient nor necessary for the development of asthma. However, asthma is one of the commonest chronic conditions affecting children and adults, yet many still remains to know of its etiology (Midodzi *et al,* 2010). Some prenatal risk factors, including maternal smoking, have been firmly established, but diet and nutrition, stress, antibiotics use and mode of delivery also affect early allergy and asthma development (Kozyrskyj *et al,* 2009). Subbarao *et al.* (2009) in Canada found that the later in childhood, putative risk factors include exposure to allergens, breastfeeding (initially protect, but increase the risk of sensitization), family size and structure, and sex and gender. In adulthood, recurrence of child-hood asthma may be just as common as new-onset asthma that may have an occupational basis. They added that better understanding of the risk factors may eventually lead to opportunities for ast-hma primary prevention. Family and twin studies showed that genetics plays a role in the development of asthma and allergy (Willemsen *et al,* 2015), through several genes of moderate effect as genes associated with relative risks in range of 1.2-2 (Holberg *et al,* 1996).

Review and General Discussion

An allergen is a type of antigen that produces an abnormally vigorous immune response in which the immune system fights off a perceived threat that would otherwise be harmless to body, and is capable of stimulating a type-I hypersensitivity reaction in the atopic individuals by immunoglobulin E (IgE) responses (Ten *et al,* 1995)

Aeroallergens: Aeroallergens are outdoors and/or indoors. Hamilton (2005) in USA reported that the main indoor aeroallergens were released from house dust mites, fur animals as dog, & cat, and insects as cockroac-

hes, fleas, lice, & bugs. Morsy (2012) in Egypt reported that systemic allergic reactions occurred due to bites of mosquitoes, many types of blood-sucking flies, fleas, bugs, lice, and ticks. Sabry *et al.* (2012) in Egypt mentioned that entomophobia or acarophobia, parasitic dermatophobia or delusional parasitosis was a disorder affected individuals by mistaken, but unshakable belief that they are infected by insects, spiders, scorpion, ticks, mites, helminthes, bacteria, or other microorganisms.

Burge and Togers (2000) in USA reported that outdoor allergens are pollens from grasses, trees, and weeds, as well as outdoor molds led to allergic disease, which required an epidemiological knowledge of allergen-bearing particles nature, source(s), and/or aerosols (particle types, sizes, dynamics of concentrations). Primary outdoor allergens include vascular plants (pollen, fern spores, soy dust), and fungi (spores, hyphae). Nonvascular plants, algae, and arthropods contribute numbers of allergen-bearing particles released from sources into the air by wind, rain, mechanical disturbance, or active discharge mechanisms

Generally speaking, the more evidence for the cause between allergen exposure and asthma came from bronchoprovocation experiments showed that the allergens cause bronchospasm, eosinophilia airway inflammation and prolonged increases in bronchial hyperreactivity (Calhoun *et al* 1994). Perhaps by specific moving of some asthmatic children or adults from their houses to different ones, low allergen residential setting results in major improvements in clinical symptoms and bronchial hyper-reactivity (Piacentini *et al,* 1996). This background indicated a powerful rationale for recommending that allergic patients should reduce allergen exposure in their houses as management part of asthma and allergic rhinitis (Sharma *et al,* 2007).

Specific monoclonal antibody-based assays have been developed to monitor allergen levels during controlled trials and to test the specific measures recommended to control exposure to indoors insects, mite, cat, dog, and others antigens (Erwin and Platts-Mills, 2005). These techniques facilitated detailed studies of specific allergens and helped to define effective control measures, but exquisite specificity of such measurements meant that some specific allergen forms (e.g., *Der. p.* 1) may not be detected (van Ree, 2007).

General principles: Allergen avoidance is appropriate for symptomatic patients with allergic responses indicated either with positive skin tests or sera assays for specific IgE antibodies (Abdel-Motagaly *et al,* 2017). By specific sensitivities definition, it was important to implement a comprehensive environmental control plan for all, or as much as possible, of allergens, which were relevant to that patient. Environmental most effective control was those in which the specific measures taken were tailored to patient and addressed major allergens to each one was sensitized (van Schayck *et al,* 2007).

The urban children with moderate-to-severe asthma represent a population regard to the impact of environmental allergen control on asthma. The comprehensive environmental modification in these children was effective in reducing asthma symptoms, but was costly effective if carefully performed (Kattan *et al,* 2005). No doubt, the patient/parent education was essential for successful environmental modification. Simply handing recommendations sheet to a patient, without detailed education about proposed measures or specific follow-up was unlikely to be effective (Wan *et al,* 1999). Clinician must be mindful that the major environmental modifications, such as removing carpets, modified heating system, or replacing old upholstered furniture, are expensive and may not be affordable for some families. The recognition and initial emphasis on low-cost interventions must enhance patient cooperation (Tovey *et al,* 1981).

House dust mite (HDM): Dust mites (*Dermatophagoides pteronyssinus* and *D. farinae*) and *Blomia tropicalis* the most important species are arachnids that colonize bedding,

sofas, carpets, or any woven material. Dust mites do not bite, and aside from causing allergic disease, are unknown to pose other harm to man. It is sometimes difficult to educate patients regarding dust mites because neither mites, nor their debris, can be seen in normal circumstances (Morsy *et al,* 1994).

Mites absorb humidity from the atmosphere and feed on organic matter (including shed human and animal skin particles), usually with the aid of fungal degradation, and nested in a source of food (rarely a limiting factor live indoors), and sufficient humidity (Arbes *et al,* 2003).

The mite fecal particles contain a complex mixture of allergenic mite-derived proteins, endotoxin, enzymes, and mite and bacterial DNA, all of which can be immunostimulatory (Cipriani *et al,* 2017). These particles are relatively large and heavy and become transiently airborne after vigorous disturbance, but then settle rapidly, such that no allergen was detectable in the air within 15 minutes. Thus, air filtration plays very small role in controlling exposure to dust mite. Instead, exposure occurred primarily by close proximity to dust mite debris during time spent in bed, on the floor, or on upholstered furniture (Ghaemmaghami *et al,* 2001).

Specific measures: Effective control measures include physical barriers, control humidity and reducing areas that can harbor dust mite colonies. Others to reduce exposure to dust mite allergens are heat treatment, insecticides, and allergen-denaturing agents. Now the dust mite is one of the occupational diseases (Saleh *et al*, 2014).

Physical barriers: Physical barriers used to control domestic allergen exposure include covers for pillows, mattresses, box springs, comforters, and furniture cushions (Lodge *et al,* 2011). The simplest types of covers are plastic, which may be uncomfortable for some patients. Considerable effort has gone into identifying alternative fabrics, including coated plastics, permeable synthetics allowing vapor and air movement, nonwoven synthetics that allow airflow without passage of particles >1μm in diameter, and finely woven fabrics with small pore sizes; 2μm (Vaughan *et al,* 1999). Woven fabrics with a designated pore size up to about 6 microns were preferable, as being very effective at controlling passage of mite and cat allergens, but still permitting adequate airflow, which may also completely block passage of immature and adult live mites (Peroni *et al,* 2004). Woven fabrics were identifiable by their smooth texture, higher relative cost, and ability to be laundered repeatedly. But, nonwoven materials, which look and feel similar to heavy weight paper toweling, can retain high levels of allergen on the surface and lose integrity with repeated washing (Miller *et al,* 2007). It was important to counsel patients that the use of bedding covers, as an isolated intervention, didn't likely to reduce rhinitis or asthma symptoms to a clinically meaningful degree. But, bedding covers must be a component of a comprehensive plan to reduce exposure to dust mite, or any other allergens that were risky to that patient (Tobias *et al,* 2004).

In a well-designed trial of 1100 adults with asthma and dust mite sensitivity were randomly assigned to receive allergen-impermeable bed covers or placebo bed covers that allowed passage of dust mite allergen. Allergen impermeable covers were associated with significant decrease in dust mite allergen in mattress dust, but asthma symptoms were not reduced (Woodcock *et al,* 2003).

In a systematic review that included just two trials, the reviewers concluded controlled trials of allergen avoidance for perennial allergic rhinitis were not convincing. This was partly for technical reasons in assessing symptoms but also because only a limited number of patients were selectively allergic to dust mite (Nurmatov *et al,* 2012). Even though the use of HDM impermeable bedding covers, as an isolated intervention, was probably not sufficient to produce clinical improvement in most patients, this intervention was nevertheless considered an essential component of any strategy to reduce

dust mite exposure. The more generalizable point is that effective allergen avoidance must target all of the allergens that are important for that patient (Shedd *et al,* 2007).

Minimizing upholstery and fabric reservoirs: Efforts should be made to restrict the presence of carpets, upholstered furniture, and drapes in the environment of dust-mite allergic person, in order to reduce the sites that can be colonized by dust mites. Dusting of surfaces and vacuuming of floors, using a vacuum equipped with a high-efficiency particular air (HEPA) filter, should be performed regularly. The numbers of stuffed toys in children's bedrooms should be minimized. Carpeting can be removed and replaced with finished floors and washable area rugs (Terreehorst *et al,* 2003). Measures were particularly important in rooms where the patient spent most time, such as the bedroom, study, and rooms where the television and computer were used (Luczynska *et al,* 2003).

Regulation of humidity: Decreasing humidity can reduce mite growth, and maintaining relative humidity below 50% is recommended. This can be accomplished by the regular opening of windows in a dry climate or air conditioning in a humid climate. Humidifier use should be avoided. Dehumidifiers can be used, but these do not generally filter the air as air conditioners do. Patients who report dry nasal passages should use saline nasal sprays before bed instead of humidifying the entire bedroom (Korsgaard, 1983).

Upper floors always have less humidity than lower ones because carpets lay on concrete slabs in a basement or at ground level tend to become and remain damp, after becoming a rich source of bacterial, fungal, and dust mite allergens (Platts-Mills *et al,* 1987). In some climates (e.g., Boston, Massachusetts), apartments have dramatically less humidity than houses and commonly have up to 10-fold less mite allergen. In such situations, moving to an apartment on the second floor or higher may be an effective method of reducing dust mite exposure.

Heat treatment: Both dry heat and steam treatments can eradicate dust mites and reduce exposure to mite allergens. A study showed that commercial steam cleaning of carpets kills dust mites and reduces dust mite allergen levels (Colloff *et al,* 1995). Asthmatic patients were randomized to receive treatment of mattresses and duvets with hot air (110°C) & steam, as well as steam cleaning of carpets versus sham treatments (Htut *et al,* 2001). A single active environmental treatment resulted in significant and sustainned reduction in *Der p* 1 & 2 HDM allergen concentrations, and a reduction in bronchial reactivity by bronchoprovocation testing that was maintained for 9 to 12 months.

Washing sheets, pillowcases, mattress pads, and blankets weekly effectively reduces mites (McDonald and Tovey, 1992). Bedding was recommended to wash in hot water with detergent, or dried in an electric clothes hot dryer (Miller and Miller, 1996).

Insecticides and allergen-denaturing agents: The use of chemicals to kill mites or denature allergens has also been investigated, but the data in favor of this approach are modest. Several chemicals were tested, but only benzyl benzoate and tannic acid have been marketed in the United States. 1- Benzyl benzoate is highly toxic to mites in a laboratory setting, but when applied to carpets, produced only a modest decrease in allergens (<60%) that was short-lived (Hayden *et al,* 1992). 2- Tannic acid potently denatures proteins in vitro, with a minimal effect when applied to mites infested carpets and other allergens (Woodfolk *et al,* 1994).

Prolonged eradication of mites is not possible with available chemicals. Permethrin or Ivermectin or Clorsulon are effective against many mites with residual effect for several weeks. Read label carefully before spraying to be sure for application to the living areas, attics and crawl spaces (Morsy *et al,* 2001).

Impact on asthma control: Many simple controlled trials successfully decreased mite allergen for six months or more after the range of interventions (Ehnert *et al,* 1992). Each of these studies reported benefit, and four

studies found a highly significant decrease in nonspecific bronchial hyper-reactivity. It was important to note that over half of the reported trials of dust mite avoidance failed as the measures proposed didn't reduce allergen exposure for a significant period of time (Platts-Mills *et al,* 1999).

There were several conclusions from these studies: 1- Successful controlled trials have used combinations of physical measures, including pillow covers, mattress covers, washing bedding in hot water, and carpet removal, rather than chemical treatments. 2- At least 3 to 6 months of sustained intervention was necessary to demonstrate clinical benefit. So, patients should be encouraged to adopt dust mite control measures that they can effectively sustain over time, and they must be advised that symptoms are expected to improve gradually (Mazyad *et al,* 2001).

Pets: Indoor pets as dogs and cats are a common source of allergens and the vast majority of pet-allergic patients are reactive to cats, dogs, or both. However, a growing number of exotic animals are kept as pets, including reptiles, birds, insects, rodents, ferrets, and monkeys, and allergic responses to these animals are also reported (Phillips and Lockey, 2009).

The most effective measure in controlling allergens derived from animals is to persuade the family or patient not to keep animals in the house. Scales shed from the animal's skin (comparable to human dander) are major source of animal allergens. Keeping a pet outdoors is effective, but restricting the animal to one part of the house is ineffective because animal allergens, particularly those from cats, are easily carried on clothing. Both cat and dog allergens are airborne for extended periods of time due to carriage on particles that, because of their small size, settle very slowly. Many patients refuse to give away their loved pets, efforts were made to control cat allergen and animal still in house (de Blay *et al,* 1991). Clinical effectiveness of the measures was not well done, and patients didn't understand that a cat in house was a large source of allergen that none of the feasible measures can consistently control allergen exposure (Wood *et al,* 1998). Even when cat was removed outdoors, allergens persist for many weeks or months (Wood *et al,* 1989). This denoted the increase in symptoms sometimes seen if a cat-allergic patient moved into a home where cats were previously living. Aggressive cleaning measures can accelerate removal allergens, but the quantity of cat allergen accumulated in carpets, sofas, and mattresses represented a major source difficult to be removed with routine cleaning (Custovic *et al,* 1996).

Cat allergen is transferred on clothing to schools, workplace and houses without a cat. The quantities found in these sites are sometimes surprisingly high, such as 80 mcg per gram of dust of the antigen Fel d 1; the major cat allergen or Can F. 1; the major dog allergen (Perzanowski *et al,* 1999). Also, the passive transferred allergen became airborne causing symptoms (Almqvist *et al,* 2001). Patients highly allergic to cat or dog allergens must be informed about this potential source of ongoing exposure (Chan and Leung, 2018). So, in homes without a pet, levels of animal allergen may be effectively reduced by feasible cleaning and use of room air cleaners, but these measures may not be effective if pet remains in home (Bollinger *et al,* 1996). But, detecting sensitization to cats was easier than dogs (Ohman *et al*, 1973).

Air filters: In general, room air cleaners might only be effective if allergen reservoirs (including the pets, old carpets and upholstered furniture) were removed, otherwise the air currents they create can increase the allergen quantity by becoming airborne. Air cleaners can reduce the concentrated air-borne animal allergens, however studies have reported confusing results as to the impact of this reduction on symptoms of allergic rhinitis and asthma (van der Heide *et al,* 1999).

An expert panel, organized by the American Academy of Allergy, Asthma, and Immunology, conducted a systematic review concluded that there was benefit evidence from

the use of air filters in patients with allergic airway disease (Tovey, 2008), but neither the magnitude of effect nor optimal techniques were proven. In most positive studies, clinical benefit was demonstrated only after a prolonged period of use (e.g., a minimum of one year). So, based on the available data, that panel suggested that allergic patients choose one of the following (Sublett *et al,* 2010): 1- A room air cleaner with a HEPA filter, particularly one that directs filtered air toward the individual's head during sleep, 2- A whole house filtration system for homes with forced air heating, & disposable HEPA filters regularly changed was a more expensive option

Aggressive cleaning: Regular cleaning and the use of a vacuum cleaner with an effective filtration system are recommended. A controlled trial showed lower allergen levels and clinical improvement in asthma measures in homes cleaned with vacuums equipped with high-efficiency particulate air (HEPA) filters, compared to vacuums without specialized filters (Popplewell *et al,* 2000). The homes in that study did not have pets, but the treatment was effective for cat allergic subjects.

Bathing pets: Effect of bathing pets regularly has been studied (Avner *et al,* 1997). Washing cats less often than weekly is unlikely to result in any meaningful improvement in symptoms, as some authors showed that cat allergen in the air returns to pre-bath levels as quickly as 24hrs later (Nageotte *et al,* 2006). Effect of washing dogs regularly was less well studied; twice weekly bathing may be helpful.

Hypoallergenic breeds: Hypoallergenic, or below average or mild allergenic is a term meant that something (usually cosmetics, food, pets, textiles…etc.) caused fewer allergic reactions, which was first used in 1953 as an advertising campaign for cosmetics (Wikipedia, 2021).

Cats: The majority of people with cat allergy are sensitized to the Fel d1 protein. A "hypoallergenic cat" has been commercially developed (Allerca; San Diego, California) by breeding cats that were naturally deficient in *Fel. d1* (Lockey, 2012). The cost of these animals is significant (between $6500 & $23,000/cat). Preliminary studies exposing cat-allergic subjects to animals showed few symptoms, although no allergen measurements were published. Further information is required to understand the clinical responses of cat-allergic individuals to these animals, both with short-term and prolonged exposure (Vredegoor *et al,* 2012).

Dogs: There is no convincing evidence that certain breeds of dogs are less allergenic than others. The best study to date compared concentrations of the major dog allergen Can f1 in samples from two groups of dogs and the homes they occupied (Ramadour e*t al,* 2005). The first group of 196 dogs consisted of breeds that are promoted on the internet or by breeders as "hypoallergenic" (e.g., Labra-doodle, Poodle, Spanish Waterdog, Airedale terrier) and the second, 160 dogs of breeds that carry no such claims (Labrador retriever and 46 other breeds, as well as various mixed breeds). Can f1 concentrations in the animals' coats, and in the settled and airborne dusts from their homes were compared. No differences were found in allergen levels in the homes of the two groups. Interestingly, concentrations of allergen in hair samples from the hypoallergenic group were significantly higher than those of the control group, although this was not reflected in home dust levels (Heutel beck *et al,* 2008). Within each breed, there was marked variability among individual animals, a phenomenon also noted in earlier studies confirmed that the findings of an earlier, smaller study (Nicholas *et al,* 2011).

Allerca also markets a hypoallergenic dog. As to the Allerca cats, data documented that these animals produce lower levels of allergens were not available to the general scientific community (Sheehan *et al,* 2009).

Rodents: Mice and rats produce urinary proteins that are allergenic in occupational (e.g., laboratory workers), school (Permaul

et al, 2012), and domestic settings (Matsui *et al,* 2005). Mouse allergens are measurable in nearly all inner-city, multifamily homes, and as many as 50% of suburban homes (Chew *et al,* 2003). But, the levels in inner-city homes have been as much as 100-fold higher than those in suburban homes, and levels in inner city schools are often higher than in homes (Matsui and Wood, 2006). Exposure of infants to mice allergens was associated with development of asthma, independent of other factors (Phipatanakul *et al,* 2005). Mouse exposure also correlates with poorer asthma control and increased health care utilization in inner-city children sensitized to mouse allergens. In adults community (non-laboratory workers), sensitization to mouse allergens was significantly associated with asthma and asthma morbidity (Matsui *et al,* 2006).

Exposure to rodents can be assessed by asking if mice or rats are ever sighted at home or if the family has seen evidence of their presence (droppings, nests). However, mouse allergen can be high even if the answers to these questions are negative, as rodents may remain entirely hidden from sight (Phipatanakul *et al,* 2007). Indoor mice and rats may represent a source of allergens, by secreting major allergens, such as *Mus musculus* m1 and *Rattus* species 1, in their urine (Phipatanakul, 2002). Rodents' main allergens represent relevant allergenic source in schools, labs, workplace and domestic environments (Ohman *et al,* 1994). Generally,
intensive contact with any animal such as reptiles, birds, and mammals, can induce allergic reactions (Pecquet, 2012). Most common allergies developed are from pets or farm mammals with fur and even human ha-irs. Cats, dogs, Guinea pigs, hamsters, and rabbits are all very popular pets in industrialized countries, where pet ownership percentage increased (Collin *et al,* 2015). Horses, whose use has decreased in agriculture, are today widely owned for recreational riding and show activities. Also, pigs, cows are the most common farm animals used for dairy and meat production. Another source of occupational animal allergies is the handling of laboratory animals kept in large numbers in research facilities of universities and pharmaceutical industries (Liccardi *et al,* 2016).

Specific control measures: Professional extermination and integrated pest management were usually necessary to reduce rodent allergen levels significantly (Sheehan *et al,* 2010). In addition to extermination, keeping food and trash in covered containers, cleaning food scraps from the floor and countertops, and sealing cracks in the walls, doors, and floors are essential for ongoing control (Phipatanakul *et al,* 2004).

Cockroaches: Evidence that allergens derived from the German cockroach, *Blattella germanica*, are important in the cities of North America has come from case control studies and provocation studies (Kang *et al,* 1979). In one study of 476 children found that the combination of specific skin test positivity and exposure to cockroach allergen was associated with significantly higher rates of hospitalization, compared to when this combination was absent; 0.37 versus 0.11 hospitalizations/child annually (Wang *et al,* 2009).

Specific control measures: Current recommendations include placing multiple baited traps or poisons, eliminating potential food sources (such as refuse and unwashed dishes), and removing reservoirs of cockroach debris and standing water (Rosenstreich *et al,* 1997). Air filtration is not helpful in reducing cockroach allergen exposure, as allergen settles quickly and does not remain airborne. Despite the ability to measure cockroach allergen and a good understanding of the measures necessary to reduce exposure (Sever *et al,* 2007), initial interventional trials were generally unsuccessful (Gergen *et al,* 1999). Cockroach allergen reduction alone is not sufficient to impact symptoms, as was shown in other studies targeting single allergens. This may be particularly true for patients living in poor conditions, who may be exposed to high levels of multiple allergens.

However, a subsequent trial that included a combined strategy to reduce exposure to cockroach, mite, and other indoor asthma triggers was successful in reducing symptoms and improving lung function in urban children with asthma (Carter *et al,* 2001).

Asian ladybugs: Asian ladybugs (ALB) (*Harmonia axyridis*) were imported to the United States from 1916 until 1990 as a biological means of controlling aphids. It was anticipated that the insects would not survive the cold of winter; however, they adapted by swarming and invading houses when temperatures drop in early fall. Allergy to Asian ladybugs has been increasingly reported as a source of seasonal indoor respiratory symptoms, mainly chronic cough, rhinitis, and asthma (Goetz, 2008). Most cases were reported in rural areas of central, midwestern, and southern United States, which bite and cause reactions (Call *et al,* 1992).

Asian ladybugs enter homes through external cracks and crevices, and then infest spaces within walls. They secrete a brown liquid that may stain walls and produce an unpleasant smell when handled. The source of allergen(s) was not clear (Yarbrough *et al,* 1999). Extracts for allergy skin testing and ALB-specific IgE immunoassays are not yet commercially available. Some allergy specialists in affected communities used extracts for skin testing using the beetles directly (Sharma *et al,* 2006).

Specific control measures: Primary protection is to have tight windows and walls to decrease access of these insects. The next most promising control measure identified to date is treatment of the outside of a house with pyrethroid prior to cold weather (Nakazawa *et al,* 2007). Other measures, such as treating already-infested walls with chemicals, sound waves, and traps have not been consistently helpful. In severe allergy cases, it may be necessary for patients to move to a more tightly-built house or into urban area.

Indoor molds: Indoor molds and fungi are most problematic in homes with high humidity, standing water, or water damage. If home of a mold-allergic patient contains visible mold or smells of mold, then remediation for allergen is in order. Pollens reach peak concentration in main countries from spring to summer, but in tropical countries is longer (Baxi and Phipatanakul, 2020).

A trial of indoor mold remediation in patients with asthma and visible mold growth in the home caused benefit regardless of whether patients were sensitized to four common allergenic molds by skin prick testing (Burr *et al,* 2007). In this study, which did not include a placebo/sham intervention, 164 homes housing 232 asthmatic patients were randomly assigned to undergo cleaning with detergent and fungicide and installation of an attic fan, or to have this intervention performed one year later. Some subjects in the control group performed mold remediation on their own. Despite this, there was a dramatic difference between the two groups at six months, with improvement in breathing symptoms in 52 & 0% of patients in the intervention and control groups, respectively, although some placebo effect was possible. Medication use decreased 41% in the intervention group, and increased 17% among control patients. The benefit in patients not sensitized to the four tested molds was posited to be secondary to reduction in mycotoxins and volatile irritant substances emitted by molds. But, the effect could also reflect a failure to identify allergic patients when using only four molds and prick tests. A randomized trial also found modest benefit (Kercsmar *et al,* 2006).

Outdoor allergens: Outdoor allergens, especially pollens and molds, are difficult to avoid short of limiting contact with the outside world. Patients with pollen and mold allergies should be advised to close the windows at home and also in the car, stay indoors when possible, and use air conditioners to filter air during symptoms peak. Showering before bed to remove allergens from hair and skin can hreduce contamination of the bedding. Over counter saline sprays and rinses can be used to wash allergens from

the nasal lining after outdoor exposure.

Treatment includes over-the-counter medications, antihistamines, nasal decongestants, allergy shots, and alternative medicine. In nasal symptoms, antihistamines were normally first option, may be together with pseudoephedrine to help relieve a stuffy nose and stop the itching and sneezing (Frieri, 2018). Some over-the-counter options were Tavist® & Benadryl® may cause drowsiness, dry mouth, blurred vision, constipation, difficulty with urination, confusion, and lightheadedness, thus patients must not operate heavy machinery or drive while taking this medication (Ozdemir *et al,* 2014). Second antihistamines generation; non-sedating antihistamines or anti-drowsy included Cetirizine, Loratadine, or Fexofenadine (Simon and Simons, 2008). Allergen immunotherapy is a dose of allergens (triggers allergic reactions) to accustom body to induce specific long tolerance orally (sublingual tablets or drops), or S.C. injections (Moingeon *et al,* 2006).

Conclusion and Recommendations

Effective indoor allergen avoidance begins with identification of those allergens that are relevant to a specific patient, either through a careful history, or preferably, with specific allergy testing. Once patient's sensitivities were defined, specific measures for each allergen should be implemented.

Principals of allergen control: 1-Control potential allergic sources (e.g., pets, rodents, cockroaches, mosquitoes, bugs, & fleas), 2-Minimize sites where mold or mite grow, 3-Minimize allergen reservoirs (upholstered sofas, carpets, and uncovered pillows or bedding). Outdoor pollen or mold spore level was difficult to control, but can minimize indoor allergens amount during outdoor pick by closing windows and doors and frequent baths to remove allergen residues on body.

Reducing indoor exposure to dust mites, animal dander, or cockroach debris, is relatively straightforward, although it can be costly. Clinicians must recognize this and emphasize less expensive measures. Regular use of high-efficiency vacuum cleaners can reduce indoor allergens exposure. Also, pets must be washed at least twice a week. For mold, try to reduce indoor humidity (<50%), remove carpets, wallpaper, and woodwork, treat washable surfaces with detergent agent, dry completely, & repair water defects

Problems arise when severely allergic patients must not give up pets, or are unwilling or unable to remove carpets; control supplies of potential food for cockroaches, and adequately reduce humidity. But, patient was exposed out-doors (e.g., cat or insect or rodents allergens at school, or workplace or anywhere). Allergic patients must stay inside during thunderstorms and in midday and afternoon, when pollen counts are highest.

Table 1: Important sources of allergens and route of exposure

Allergen source	Human exposure route
Grass pollens	Inhalation (outdoor)
Weed pollens	Inhalation (outdoor)
Tree pollens	Inhalation (outdoor)
Mold (hyphae-spores)	Inhalation (outdoor and indoor)
House dust mite fecal material	Inhalation (indoor)
Animal proteins (epidermal and serum)	Inhalation (indoor)
Foods	Ingestion
Blood-sucking and non-blood sucking Insects	Inhalation-injection (indoor and outdoor)
Hymenoptera venoms (local and systemic allergy)	Injection
Parasites	Ingestion-injection
Drugs	Injection-ingestion
Occupational	Contact-inhalation-ingestion

Table 2: Avoidance measures for animal's dander

Pet animals remove	Keep animals outside, e.g., in garage or kennel; restricting animals to certain rooms ineffective?
	Once removed animals, premises should be cleaned thoroughly.
Control allerg-en & pet anim-als	Difficult because animal contains 10-50mg of major allergen, but quantities of airborne allergen only 5-20ng/m^3. Using an air filter can only reduce airborne allergen.
	Reduce reservoirs: remove carpets, reduce upholstered furniture, replace drapes with blinds, or/and vacuum clean weekly with good filtration, i.e., double thickness bags and/or HEPA filtration.
	Room air filters: HEPA or electrostatic (maintenance data are better defined for HEPA).
	Washing cats not reduce allergen levels significantly. Washing dogs twice a week may help.
	Pet dog and cat bath with warm water and animal shampoo.
	Pet dog or cat poop, 1-Bury it, 2- Flush down toilet, and 3- Use biodegradable bags, and dispose bags in right places.

Table 3: Avoidance measures for dust mites

Bedrooms	Cover pillows and mattresses with zippered covers which are impermeable to mites and mite allergens.
	Family size per bedroom
	Wash sheets, pillowcases, and blankets in warm water with detergent or dry in an electric dryer on hot setting weekly; when necessary, blankets should be replaced with washable ones. Comforters should be removed.
	Use washable, vinyl, or roll-type window covers.
	Remove clutter, soft toys, and upholstered furniture.
	Where possible, carpets should be removed or replaced with area rugs that can be cleaned/washed
Rest of house	Reduce upholstered furniture, particularly old sofas.
	Replace carpets with polished flooring where possible. Carpets on concrete slabs or over poorly ventilated crawl spaces are a problem and should be replaced with polished flooring if possible.
	Vacuum weekly using a cleaner with a HEPA filtration system.
	Window coverings should be washable, vinyl, or roll type.
	Control humidity to <50% relative humidity at normal temperatures, i.e., 68 to 72°F
Changing houses	Allergy sufferers must not be encouraged to move from home except if lin basements or overtly damp houses.
	Individuals allergic to mites (or molds) should be advised about potential benefit of moving to an apartment (2nd or high floor) or a house with 2nd floor bedrooms and wooden floors.
Private Car	Remove clutter, soft toys, and any books or advertisement paper
	Where possible, carpets should be removed or replaced with area rugs that can be cleaned/washed

Table 4: Basic measures to control exposure to indoor allergens

allergen	recommendations
Animal dander	Remove pets, or at minimum, keep animal out of bedroom. Keep pets in a HEPA filter room and replace filter as indicated
	Cover air ducts that lead to bedroom with filters. Replace filters as recommended by manufacturer.
	Use air filters and vacuums with HEPA filters. Replace the filter as recommended by manufacturer.
HDM	Less costly
	Encase mattress, pillows, & box spring in allergen-impermeable covers. Finely woven covers for pillows & duvets preferable
	Wash bedding weekly in warm water with detergent or use electric dryer on hot setting.
	Reduce indoor humidity to <50%
	More costly, remove carpets from the bedroom
	More costly, replace old upholstered furniture with leather, vinyl, or wood
Cock-roaches	Use poison bait or traps to control. Consult professional exterminator for severe infestation.
	Periodically clean home thoroughly.
	Encase all food fully and do not store garbage or papers inside the home.
	Fix water leaks
Mosqui-toes	Screening of doors and windows
	Fix water leaks in the garden
	Keep mosquito repellent plants, and sliced lemon and cloves around house.
	Indoor Use a garlic spray to control mosquitoes. ..
	Indoor keep a dish of soapy water, a dish of beer or alcohol.
Bed bug	A comprehensive IPM program to control bed bugs may include non-chemical and chemical methods.
	Non-chemical: Put bedding & clothing in dryer at high Temp. 30minutes (just washing not kill bed bug).
	Pyrethrins and ivomec commonest compounds used to control bed bugs and other indoor pests
Fleas	A handful of homemade flea remedies you can try to help prevent and get rid of fleas
	Indoor flea remedy involves creating a flea trap using dish soap and some water. ...
	Natural fleas repellants Citronella, Lemon spray eucalyptus, peppermint, tea tree, baking soda and rosemary
	Sprinkling floor with Diatomaceous earth.
	Chosen essential oil into a 300-400ml of water and spray directly onto coat of pet dog or cat.
Indoor mold	Clean moldy surfaces with dilute bleach solution & fix all water leaks.
	Reduce indoor humidity to <50%. Avoid use of humidifiers.
	Evaporative (or swamp) coolers should be avoided or cleaned regularly.
Rodents	Consult a professional for periodically clean home. Repair holes in walls, doors, floors, and block other entry points.
	All food should be stored in sealed containers. Do not store garbage inside.

References

Arbes, SJ, Jr, Cohn, RD, Yin, M, Muilenberg, ML, Burge, HA, *et al,* 2003: House dust mite allergen in U.S. Beds: Results from the first national survey of lead and allergens in housing. J. Allergy Clin. Immunol. 111, 2:408-14.

Abdel-Motagaly, AME, Mohamad, HM, Morsy, TA, 2017: A mini-review on skeeter syndrome or large local allergy to mosquito bites. J. Egypt. Soc. Parasitol. 47, 2:415-24.

Almqvist, C, Wickman, M, Perfetti, L, *et al,* 2001: Worsening of asthma in children allergic to cats, after indirect exposure to cat at school. Am. J. Respir. Crit. Care Med. 163:694-9.

Avner, DB, Perzanowski, MS, Platts-Mills, T A, Woodfolk, JA, 1997: Evaluation of different techniques for washing cats: Quantitation of allergen removed from the cat and the effect on airborne *Fel. d.* 1. J. Allergy Clin. Immunol. 100: 307-10.

Baxi, SN, Phipatanakul, W, 2010: The role of allergen exposure and avoidance in asthma. Adolesc. Med. State Art Rev. 21, 1:57-71

Bollinger, ME, Eggleston, PA, Flanagan, E, Wood, RA, 1996: Cat antigen in homes with and without cats may induce allergic symptoms. J. Allergy Clin. Immunol. 97:907-12.

Burge, HA, Rogers, CA, 2000: Outdoor allergens. Environ. Hlth. Perspect. 108, 4:S653-9.

Burke, W, Fesinmeyer, M, Reed, K, Hampson, L, Carlsten, C, 2003: Family history as a predictor of asthma risk. Am. J. Prev. Med. 24, 2:160-9.

Burr, ML, Matthews, IP, Arthur, RA, *et al,* 2007: Effects on patients with asthma of eradicating visible indoor mould: A randomized controlled trial. Thorax 62:767-72.

Calhoun, WJ, Dick, EC, Schwartz, LB, Busse, WW, 1994: A common cold virus, rhinovirus 16, potentiates airway inflammation after segmental antigen bronchoprovocation in allergic subjects. J. Clin. Invest. 94:2200-4.

Call, RS, Smith, TF, Morris, E, *et al,* 1992: Risk factors for asthma in inner city children. J. Pediatr. 121:862-6.

Carter, MC, Perzanowski, MS, Raymond, A, Platts-Mills, TA, 2001: Home intervention in the treatment of asthma among inner-city children. J. Allergy Clin. Immunol.108:732-6.

Chan, SK, Leung, DYM, 2018: Dog and cat allergies: Current state of diagnostic approaches & challenges. Allergy Asthma Immunol Res. 10, 2: 97-105.

Chew, GL, Perzanowski, MS, Miller, R, *et al,* 2003: Distribution and determinants of mouse allergen exposure in low-income New York City apartments. Environ. Hlth. Perspect. 111:348-52.

Cipriani, F, Calamelli, E, Ricci, G, 2017: Allergen avoidance in allergic asthma. Front. Pediatr. 2017, 5:103. Published online 2017 May 10. doi: 10.3389/fped.2017.00103.

Collin, SM, Granell, R, Westgarth, C, Murray, J, Paul, E, *et al,* 2015: Pet ownership is associated with increased risk of non-atopic asthma and reduced risk of atopy in childhood: Findings from a UK birth cohort. Clin. Exp. Allergy 45, 1:200-10.

Colloff, MJ, Taylor, C, Merrett, TG, 1995: The use of domestic steam cleaning for the control of house dust mites. Clin. Exp. Allergy 25: 1061-8.

Custovic, A, Green, R, Taggart, SC, *et al,* 1996: Domestic allergens in public places. II: Dog (*Can* f1) and cockroach (*Bla g* 2) allergens in dust and mite, cat, dog and cockroach allergens in the air in public buildings. Clin. Exp. Allergy 26:1246-9.

de Blay, F, Chapman, MD, Platts-Mills, TA, 1991: Airborne cat allergen (*Fel d* I): Environmental control with the cat in situ. Am. Rev. Respir. Dis. 143:1334-8.

Ehnert, B, Lau-Schadendorf, S, Weber, A, *et al,* 1992: Reducing domestic exposure to dust mite allergen reduces bronchial hyper-reactivity in sensitive children with asthma. J. Allergy Clin. Immunol. 90:135-40.

Erwin, EA, Platts-Mills, TA, 2005: Allergens. Immunol. Allergy Clin. North Am. 25:1-8.

Frieri, M, 2018: Mast cell activation syndrome. Clin. Rev. Allergy Immunol. 54, 3:353-65.

Gergen, PJ, Mortimer, KM, Eggleston, PA, *et al,* 1999: Results of the National Cooperative Inner-City Asthma Study (NCICAS) environmental intervention to reduce cockroach allergen exposure in inner-city homes. J. Allergy Clin. Immunol. 103:501-8.

Ghaemmaghami, AM, Robins, A, Gough, L, *et al,* 2001: Human T cell subset commitment determined by the intrinsic property of antigen: the proteolytic activity of the major mite allergen *Der p* 1 conditions T cells to produce more IL-4 and less IFN-gamma. Eur. J. Immunol. 31: 1211-6.

Goetz, DW, 2008: Harmonia axyridis ladybug invasion and allergy. Allergy Asthma Proc. 29: 123-9.

Hamilton, RG, 2005: Assessment of indoor allergen exposure. Curr. Allergy Asthma Rep. 5: 394-400.

Hayden, ML, Rose, G, Diduch, KB, *et al,* 1992: Benzyl benzoate moist powder: investigation of acaricidal (correction of acarical) activity in cultures and reduction of dust mite allergens in carpets. J. Allergy Clin. Immunol. 89:536-40.

Heutelbeck, AR, Schulz, T, Bergmann, KC, Hallier, E, 2008: Environmental exposure to allergens of different dog breeds and relevance in allergological diagnostics. J. Toxicol. Environ. Hlth. 71:A751-8.

Holberg, CJ, Elston, RC, Halonen, M, Wright, AL, Taussig, LM, *et al,* 1996: Segregation analysis of physician-diagnosed asthma in Hispanic and non-Hispanic white families. A recessive component? Am. J. Respir. Crit. Care Med. 154, 1:144-50.

Htut, T, Higenbottam, TW, Gill, GW, *et al,*

2001: Eradication of house dust mite from homes of atopic asthmatic subjects: a double-blind trial. J. Allergy Clin. Immunol. 107:55-60.

Kang, B, Vellody, D, Homburger, H, Yunginger, JW, 1979: Cockroach cause of allergic asthma: Its specificity and immunologic profile. J. Allergy Clin. Immunol. 63:80-4.

Kattan, M, Stearns, SC, Crain, EF, *et al,* 2005: Cost-effectiveness of a home-based environmental intervention for inner-city children with asthma. J. Allergy Clin. Immunol. 116: 1058-62.

Kercsmar, CM, Dearborn, DG, Schluchter, M, *et al,* 2006: Reduction in asthma morbidity in children as a result of home remediation aimed at moisture sources. Environ. Hlth. Persp ect. 114:1574-9.

Korsgaard, J, 1983: House-dust mites and absolute indoor humidity. Allergy 38:85-9.

Kozyrskyj, AL, HayGlass, KT, Sandford, AJ, Paré, PD, Chan-Yeung, M, *et al,* 2009: A novel study design to investigate the early-life origins of asthma in children (SAGE study). Allergy 64, 8:1185-93.

Liccardi, G, Triggiani, M, Piccolo, A, Salzillo A, Parente, R, *et al,* 2016: Sensitization to common and uncommon pets or other furry animals: Which may be common mechanisms? Transl. Med. UniSa. 14: 9-14.

Lockey, RF, 2012: The myth of hypoallergenic dogs (and cats). J. Allergy Clin. Immunol. 130: 910-6.

Lodge, CJ, Lowe, AJ, Gurrin, LC, *et al,* 2011: House dust mite sensitization in toddlers predicts current wheeze at age 12 years. J. Allergy Clin. Immunol.128:782.e9-788.e9

Luczynska, C, Tredwell, E, Smeeton, N, Burney, P, 2003: A randomized controlled trial of mite allergen-impermeable bed covers in adult mite-sensitized asthmatics. Clin. Exp. Allergy 33:1648-52.

Matsui, EC, Eggleston, PA, Buckley, TJ, *et al,* 2006: Household mouse allergen exposure and asthma morbidity in Inner-City Preschool Children. Ann. Allergy Asthma Immunol. 97:514-9.

Matsui, EC, Simons, E, Rand, C, *et al,* 2005: Airborne mouse allergen in the homes of inner-city children with asthma. J. Allergy Clin. Immunol. 115:358-62.

Matsui, EC, Wood, RA, 2006: Questions physicians often ask about allergens that trigger asthma. J. Respir. Dis. 27:511-8.

Mazyad, SAM, Sanad, EM, Morsy, TA, 2001: Two types of scab mites infesting man and sheep in North Sinai. J. Egypt. Soc. Parasitol. 31, 1:213-22.

McDonald, LG, Tovey, E, 1992: The role of water temperature and laundry procedures in reducing house dust mite populations and allergen content of bedding. J. Allergy Clin. Immunol. 90:599-604.

Midodzi, WK, Rowe, BH, Majaesic, CM, Saunders, LD, Senthilselvan, A, *et al,* 2010: Early life factors associated with incidence of physician-diagnosed asthma in preschool children: Results from the Canadian Early Childhood Development cohort study. J. Asthma 47, 1:7-13.

Miller, JD, Miller, A, 1996: Ten minutes in a clothes dryer kills all mites in blankets. J. Allergy Clin. Immunol. 97:423-8.

Miller, JD, Naccara, L, Satinover, S, Platts-Mills, TA, 2007: Nonwoven in contrast to woven mattress encasings accumulate mite and cat allergen. J. Allergy Clin. Immunol. 120:977-82.

Moingeon, P, Batard, T, Fadel, R, Frati, F, Sieber, J, *et al,* 2006: Immune mechanisms of allergen-specific sublingual immunotherapy Allergy 61, 2:151-65.

Morsy, TA, 2012: Insect bites and what is eating you? J. Egypt. Soc. Parasitol. 42, 2:291-308.

Morsy, TA, Zohdi, HW, Abdalla, KF, El Fakahani, AF, Ibrahim A.A, *et al,* 1994: Isolation of three species of mites from house dust of atopic dermatitis patients in Qualyobia Governorate, Egypt. J. Egypt. Soc. Parasitol. 24, 2:323-32.

Morsy, TA, Habib, KSM, Haridy, FM, 2001: Ivermectin and clorsulon (ivomec super) in treatment of goats naturally infested with scab mites and biting lice. J. Egypt. Soc. Parasitol. 31, 2:373-9.

Nageotte, C, Park, M, Havstad, S, *et al,* 2006: Duration of airborne *Fel d* 1 reduction after cat-washing. J. Allergy Clin. Immunol. 118:521-8.

Nakazawa, T, Satinover, SM, Naccara, L, *et al,* 2007: Asian ladybugs (*Harmonia axyridis*): A new seasonal indoor allergen. J. Allergy Clin. Immunol. 19:421-8.

Nicholas, CE, Wegienka, GR, Havstad, SL, *et al,* 2011: Dog allergen levels in homes with hypo-allergenic compared with non-hypoallergenic dogs. Am. J. Rhinol. Allergy 25:252-8.

Nurmatov, U, van Schayck, CP, Hurwitz, B, Sheikh, A, 2012: House dust mite avoidance measures for perennial allergic rhinitis: An updated cochrane systematic review. Allergy 67:158 -62.

Ohman, JL, Jr, Hagberg, K, MacDonald, M R, Jones, RR Jr, *et al,* 1994: Distribution of airborne mouse allergen in a major mouse breeding facility. J. Allergy Clin. Immunol. 94, 5:810-7.

Ozdemir, PG, Karadag, AS, Selvi, Y, *et al,* 2014: Assessment of the effects of antihistamine drugs on mood, sleep quality, sleepiness, and dream anxiety. Int. J. Psychiat. Clin. Pract. 3: 161-8

Ohman, JL, Lowell, FC, Bloch, KJ, 1973: Allergens of mammalian origin: characterization of allergen extracted from cat pelts. J. Allergy Clin. Immunol. 52, 4:231-41.

Permaul, P, Hoffman, E, Fu, C, *et al,* 2012: Allergens in urban schools and homes of children with asthma. Pediatr. Allergy Immunol. 23: 543-48.

Perzanowski, MS, Rönmark, E, Nold, B, *et al,* 1999: Relevance of allergens from cats and dogs to asthma in the northernmost province of Sweden: schools as a major site of exposure. J. Allergy Clin. Immunol. 103:1018-21.

Phillips, JF, Lockey, RF, 2009: Exotic pet allergy. J. Allergy Clin. Immunol. 123:513-8.

Phipatanakul, W, 2002: Rodent allergens. Curr. Allergy Asthma Rep. 2, 5:412-6.

Phipatanakul, W, Celedón, JC, Sredl, DL, *et al,* 2005: Mouse exposure and wheeze in the first year of life. Ann. Allergy Asthma Immunol. 94:593-8.

Phipatanakul, W, Cronin, B, Wood, RA, *et al,* 2004: Effect of environmental intervention on mouse allergen levels in homes of inner-city Boston children with asthma. Ann. Allergy Asthma Immunol. 92:420-6.

Phipatanakul, W, Litonjua, AA, Mills, TA, *et al,* 2007: Sensitization to mouse allergen and asthma and asthma morbidity among women in Boston. J. Allergy Clin. Immunol. 120: 954-60.

Piacentini, GL, Martinati, L, Mingoni, S, Boner, AL, 1996: Influence of allergen avoidance on the eosinophil phase of airway inflammation in children with allergic asthma. J. Allergy Clin. Immunol. 97:1079-84.

Platts-Mills, TA, 2007: The role of indoor allergens in chronic allergic disease. J. Allergy Clin. Immunol. 119:297-300.

Platts-Mills, TA, Chapman, MD, Wheatly, L M, 1999: Control of house dust mite in managing asthma: Conclusions of meta-analysis are wrong. BMJ 318:870-6.

Platts-Mills, TA, Hayden, ML, Chapman, M D, Wilkins, SR, 1987: Seasonal variation in dust mite and grass-pollen allergens in dust from the houses of patients with asthma. J. Allergy Clin. Immunol. 79:781-8.

Platts-Mills, TA, Vervloet, D, Thomas, WR, *et al,* 1997: Indoor allergens and asthma: Report of the 3rd International Workshop. J. Allergy Clin. Immunol.100:S2-8.

Pecquet, C, 2012: New pets and allergies. Eur. J. Dermatol. 22, 1:14–2210.

Peroni, DG, Ress, M, Pigozzi, R, Giudice, M M, Bodini, A, *et al,* 2004: Efficacy in allergen control & air permeability of different materials used for bed encasement. Allergy 59, 9:969-72

Popplewell, EJ, Innes, VA, Lloyd-Hughes, S, *et al,* 2000: The effect of high-efficiency and standard vacuum-cleaners on mite, cat and dog allergen levels and clinical progress. Pediatr. Allergy Immunol. 11:142-6.

Ramadour M, Guetat M, e*t al,* 2005: Dog factor differences in *Can f* 1 allergen production. Allergy 60:1060-6.

Rosenstreich, DL, Eggleston, P, Kattan, M, *et al,* 1997: The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. N. Engl. J. Med. 336:1356-60.

Sabry, AH, Fouad, MA, Morsy, ATA, 2012: Entomophobia, acarophobia, parasitic dermatophobia or delusional parasitosis. J. Egypt. Soc. Parasitol. 42, 2:417-30.

Saleh, AMA, Ali, HA, Ahmed, SAM, Mohammad, NM, Morsy, T.A, 2013: House dust mites: A risk factor to be considered for occupational safety or source of work-related allergens. J. Egypt. Soc. Parasitol. 43, 3:669-78

Sever, ML, Arbes, SJ, Gore, JC, *et al,* 2007: Cockroach allergen reduction by cockroach control alone in low-income urban homes: A randomized control trial. J. Allergy Clin. Immunol. 120:849-54.

Sharma, HP, Hansel, NN, Matsui, E, *et al,* 2007: Indoor environmental influences on children's asthma. Pediatr. Clin. North Am. 54:103-8.

Sharma, K, Muldoon, SB, Potter, MF, Pence, H, 2006: Ladybug hypersensitivity among residdents of homes infested with ladybugs in Kentucky. Ann. Allergy Asthma Immunol. 97:528-34.

Shedd, AD, Peters, JI, Wood, P, *et al,* 2007: Impact of home environment characteristics on asthma quality of life and symptom scores. J. Asthma 44:183-6.

Sheehan, WJ, Rangsithienchai, P, Muilenberg M, *et al,* 2009: Mouse allergens in urban eleme-

ntary schools and homes of children with asthma. Ann. Allergy Asthma Immunol. 102:125-30.
Sheehan, W, Rangsithienchai, P, Wood, RA, *et al,* 2010: Pest and allergen exposure & abatement in inner-city asthma: American Academy of Allergy, Asthma & Immunology Indoor Allergy/Air Pollution Committee. J. Allergy Clin. Immunol. 125:575-80.
Simon, EFR, Simons, KJ, 2008: H_1 antihistamines: Current status and future directions. Published online 2008 Sep. 15.
Squillace, S, Sporik, R, Rakes, G, *et al*, 1997: Sensitization to dust mites as a dominant risk factor for asthma among adolescents living in central Virginia: Multiple regression analysis of a population-based study. Am. J. Respir. Crit. Care Med. 156:1760-6.
Subbarao, P, Mandhane, PJ, Sears, M, 2009: Asthma: Epidemiology, etiology and risk factors. C MAJ. 181, 9:E181-90.
Sublett, JL, Seltzer, J, Burkhead, R, *et al,* 2010: Air filters and air cleaners: rostrum by the American Academy of Allergy, Asthma & Immunology Indoor Allergen Committee. J. Allergy Clin. Immunol.125:32-8.
Ten, RM, Klein, JS, Frigas, E, 1995: Allergy skin testing. Mayo Clin. Proceed. **70**, 8:783-4.
Terreehorst, I, Hak, E, Oosting, J, *et al,* 2003: Evaluation of impermeable covers for bedding in patients with allergic rhinitis. N. Engl. J. Med. 349:237-42.
Tobias, KR, Ferriani, VP, Chapman, MD, Arruda, LK, Tobias, KR, *et al,* 2004: Exposure to indoor allergens in homes of patients with asthma and/or rhinitis in southeast Brazil: Effect of mattress and pillow covers on mite allergen levels. Int. Arch. Allergy Immunol. 133, 4:365-70.
Tovey, ER, 2008: Allergen avoidance. Curr. Allergy Asthma Rep. 8:126-32
Tovey, ER, Chapman, MD, Wells, CW, Platts-Mills, TA, 1981: The distribution of dust mite allergen in the houses of patients with asthma. Am. Rev. Respir. Dis. 124:630-5.
van der Heide, S, van Aalderen, WM, Kauffman, Dubois, AE, *et al,* 1999: Clinical effects of air cleaners in homes of asthmatic children sensitized to pet allergens. J. Allergy Clin. Immuol. 104: 447-50.
van Ree, R, 2007: Indoor allergens: Relevance-of major allergen measurements and standardization. J. Allergy Clin. Immunol.119:270-4.
van Schayck O, Maas, T, Kaper J, *et al,* 2007: Is there any role for allergen avoidance in the primary prevention of childhood asthma? J. Allergy Clin. Immunol. 119:1323-30.
Vaughan, J, McLaughlin, T, Perzanowski, M S, Platts-Mills, TA, 1999: Evaluation of materials used for bedding encasement: Effect of pore size in blocking cat and dust mite allergen. J. Allergy Clin. Immunol. 103:227-32.
Vredegoor DW, Willemse T, Chapman MD, *et al,* 2012: Can f 1 levels in hair and homes of different dog breeds: Lack of evidence to describe any dog breed as hypoallergenic. J. Allergy Clin. Immunol. 130:904-9.
Wan, H, Winton, HL, Soeller, C, *et al,* 1999: *Der p* 1 facilitates transepithelial allergen delivery by disruption of tight junctions. J. Clin. Invest. 104:123-6.
Wang, J, Visness, CM, Calatroni, A, *et al,* 2009: Effect of environmental allergen sensitization on asthma morbidity in inner-city asthmatic children. Clin. Exp. Allergy 39:1381-6.
Willemsen, G, van Beijsterveldt, T, van Baal, C, *et al,* 2008: Heritability of self-reported asthma and allergy: In adult Dutch twins, siblings and parents. Twin Res. Hum. Genet. 11:132-42.
Wikipedia, 2021: Hypoallergenic: Free Encyclopedia
Wood, RA, Chapman, MD, Adkinson, NF, *et al,* 1989: The effect of cat removal on allergen content in household-dust samples. J. Allergy Clin. Immunol. 83:730-6.
Wood, RA, Johnson, EF, Van Natta, ML, *et al,* 1998: A placebo-controlled trial of a HEPA air cleaner in the treatment of cat allergy. Am. J. Respir. Crit. Care Med. 158:115-8.
Woodcock, A, Forster, L, Matthews, E, *et al,* 2003: Control of exposure to mite allergen and allergen-impermeable bed covers for adults with asthma. N. Engl. J. Med. 349:225-30.
Woodfolk, J, Hayden, L, Miller, J, *et al,* 1994: Chemical treatment of carpets to reduce allergen: A study of the effects of tannic acid on indoor allergens. J. Allergy Clin. Immunol. 94:19-24.
Yarbrough, J, Armstrong, J, Blumberg, M, *et al,* 1999: Allergic rhinoconjunctivitis caused by *Harmonia axyridis* (Asian lady beetle, Japanese lady beetle, or lady bug). J. Allergy Clin. Immunol. 104:704-6.