

IMPACT OF INDOORS PETS (CATS, DOGS, AND BIRDS) ON ALLERGIC DISEASES: A SYSTEMATIC REVIEW

By

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Abstract

No doubt, the value of pets (mainly cats, and/or dogs) extends far beyond their adorable appearances, boosting the mental health to fostering deeper human connections. Nevertheless, they are risky to the owners mainly babies, and children via bites and scratches, falls from being knocked over by the pet, & choking on pet toys or food. Besides, allergies or asthma caused by pet's fur, saliva, feathers or skin flakes (dandruff) zoonotic infectious diseases usually from poo, food, water or litter trays. This reviews the several concepts that have taken shape in recent decades and discuss how these apply to common patient concerns.

Key words: Pets, Indoors, Adorable, daily care, Allergies, Zoonotic infectious diseases.

Introduction

Asthma is one of the most common chronic, non-communicable diseases; affects all ages, particularly children, with world prevalence was 9.8%-17.9% (Song *et al*, 2022). In allergic diseases, it is important to differentiate between the sensitization and allergy. Sensitization refers to the allergen-specific IgE production (Elsheikha *et al*, 2008), and usually detected by skin testing or *in-vitro* immunoassays for IgE to specific allergens RAST, but described the test an antiquated form (Arshad *et al*, 2001). Sensitization to an allergen is not synonymous with an allergic to that allergen; as someone may produce IgE to a certain substance, without developing symptoms upon exposure to this substance. Individuals have clinically significant allergy or allergic disease; when having allergic specific IgE and develop symptoms on exposure to allergen substances (Hesselmar *et al*, 2003). So, the great majority of people are sensitized to an allergen than being clinically allergic to it. IgE is one of the five human isotypes, IgG, IgA, IgM, & IgD, but the last one is a defense against some parasites, in mast cell & basophil de-granulation, antigen presentation, and central to many allergic diseases pathogenesis (Oettgen and Geha, 2001). It is produced by the plasma cells and antigen-specific IgE primarily occurs in the mucosal lymphoid tissues, especially tonsils,

and adenoids as well as plays a pivotal role in responses to allergens, such as anaphylactic reactions to drugs, bee stings, and desensitization immunotherapy antigen (Hawam *et al*, 2024). Metbulut *et al*. (2023) mentioned that elevated serum IgE levels in allergic diseases must be differentially diagnosed from infections, parasites, hematologic malignancies, chronic lung diseases, and other inflammatory diseases, such as nephrotic syndrome, cystic fibrosis, and HIV/AIDS (PIDs).

Review and General Discussion

Epidemiologically, a strong positive correlation was found between sensitization to cat and/or dog allergens and asthma (Bufford *et al*, 2004), and to a less degree, allergic rhinitis (Stoltz *et al*, 2013). In different cohorts, odds ratio for asthma associated to cat and/or dog sensitization ranged from 3 to 9.2, with consistent highly significant (Remes *et al*, 2001). Therefore, it is critically important to know whether living with a pet increases or decreases the likelihood of sensitization to allergens and ultimately, the risk of developing allergic disease (Sandin *et al*, 2004).

Cat exposure causes sensitization and asthma: In the late 1990s, the children living in a house with a cat were less likely to be sensitized to cat allergens, or had cat-specific IgE (Ingram *et al*, 1999). But, this contradicted accepted view that more allergen exposure correlated with greater likelihood of sensit-

ization detected with house dust mite and/or cockroach (Custovic *et al*, 2003). Since then, studies proved that highest cat levels exposure were associated with decreased sensitization (Perzanowski *et al*, 2002), but Ownby *et al*. (2002) didn't find any increase in sensitization among children living with a pet cat. The dose response in both studies varied between a true bell-shaped curve, and a plateau, but without increase in highest exposure (Platts-Mills *et al*, 2002). Evidence from a birth cohort in an area with IgE antibodies to pet allergens was a major risk factor for asthma showed that most cat-allergic children with asthma (85%) didn't have cat (Perzanowski *et al*, 2016). High-IgE antibodies to cat or molecular allergens were associated with asthma higher odds (Sporik *et al*, 1999).

Immunologic changes: Reason why cat exposure caused different immunologic changes compared to house dust mite or cockroach exposure was not clear (Erwin *et al*, 2014). There is some evidence that living with a cat results in cat-specific tolerance. Developed an eleven-year-old school aged child, the sensitization prevalence to cat rose as exposure increased from very low to moderate levels, but decreased at highest exposure levels (Platts-Mills *et al*, 2001). However, the IgG antibodies to major cat allergen (Fel d 1) increased with exposure increased to cat allergen level in patients underwent allergen immunotherapy with inhalant allergens to treat allergic rhinitis and asthma (Shamji *et al*, 2012). So, some children and adults living in pet cats developed IgG antibodies to a major cat allergen, but with neither IgE antibodies nor positive skin tests (Nanda *et al*, 2004). This response didn't seem to be cats' exposure symptoms (Campbell *et al*, 2009). Besides, *in-vitro* exposure of T cells from the subjects to distinct peptides of Fel d 1 increased the IL-10 production supporting that this was a tolerance form (Reefer *et al*, 2010).

Mechanisms: The high exposure levels suggested possible because Fel d 1 is associated with small particles and is suspended in the air for a long time (de Blay *et al*, 1991). But,

exposure to cat and/or dog allergen airborne in homes was up to 100 times higher than exposure to house dust mite allergen living with a model where immunological tolerance to their dander allergens (Custis *et al*, 2003). But, allergens from house dust mite or cockroach are carried out on larger particles deposited on the ground reached high airborne levels only by disturbance (Custovic *et al*, 1998). The Fel d 1 is environmentally dispersed in the public places and homes without cats at a measureable level sufficient to airborne (Bollinger *et al*, 1996). The exposure levels in schools and/or homes without a cat were sufficient to sensitize, since most of the cat-allergic children didn't have a pet cat (Gelber *et al*, 2003). In a home without cat, dust mite contained 80mcg Fel d 1/gm of dust more or less compatible to that common with a pet cat (Platts-Mills *et al*, 2005). The exposure to high levels of Fel d 1 causes lower sensitization rates, although less developed than the first, concern biological allergen properties as Fel d 1 is a uteroglobin protein homologous to Clara cell secretory protein in mice lungs (Platts-Mills and Woodfolk, 2011). A single allergen of uteroglobin protein family is at least as good as cat dander extract in cat-allergic patients (Grönlund *et al*, 2010). These proteins have intrinsic anti-inflammatory effects, and glycosylation of major Fel d 1 allergen facilitated gastrointestinal absorption and different immune responses (Wisniewski *et al*, 2013). In Central Europe, sensitization to animal allergen molecules is very frequent to the species-specific cat uteroglobin Fel d 1, dog Kallikrein Can f 5, and then to animal lipocalins (Vachová *et al*, 2020).

Dog exposure and allergy: Early dog exposure on first few years of life in home protected from the asthma development or wheezing (Mandhane *et al*, 2009). This early pet dog exposure lowers the risk of sensitization to an array of allergens, as though dog exposure has a more general protective effect to allergic disease (Wegienka *et al*, 2011). But, sensitization varied depended on the age of

the exposed children with possible modification effect related to these factors (Wegienka *et al*, 2017). Also, among Sweden IgE negative patients to dander with symptoms to dog, 20% were IgE positive to its saliva (Polovic *et al*, 2013). A 54-year-old man hemophagocytic lymphohistiocytosis (HLH) in a pet dog saliva showed life-threatening syndrome, meanwhile pet dog altered bacteria diversity development in babies gastrointestinal tract (Fujimura *et al*, 2010). So, many microbes with higher endotoxin levels were detected in pet dogs (Campo *et al*, 2006). Pet cats and dogs significantly contributed to the living room and bedroom floor endotoxins, but good home cleanliness might reduce the endotoxins more than removing pets away (Ownby *et al*, 2013). However, household dust samples showed that endotoxin was a micro-measured microbial products exposure (Liu, 2004). Microbial exposures in doors with a cat have not been extensively studied, although the available data don't show that pet cats increase floor dust and/or airborne endotoxin levels as pet dogs do or have the same protective effect (Sohy *et al*, 2006). But, many reports showed that microbial quantity exposures and/or microbial diversity were more relevant (Karvonen *et al*, 2014). The particular microbes or microbial products influences the body immune type response develops to a specific antigen, in some cases protect against allergic responses development (Kishimoto and Ishizaka, 1973). Rodents immunized with antigen in alum induces IgE antibody production, but using the same antigen with complete Freund's adjuvant with inactivated mycobacterial cell walls didn't produce IgE (Takenaka *et al*, 1993). Allergens exposure to adjuvants may act as a kind of allergen immuno-therapy and children having pet dogs could be exposed to allergens combined with endotoxin adjuvants microbial products (Salo and Zeldin, 2009).

The life time of an individual exposed to a pets and exposure effect: 1- The first years of life: Animal studies suggested that early exposure to allergens can have highly signif-

icant effects relevant to sensitization or tolerance, but very few human studies proved this due to confounding factors. Most birth cohort studies lacked either accurate documentation of early exposure or lacked sufficient children numbers exposed to pets for the first year of life. Nevertheless, relatively convincing results reported in the birth cohort study showed that cat exposure in first year of life was associated with decreased sensitization to cat allergens at 18years old (Ege *et al*, 2012). But, long-term effects of early dog exposure were less clear. 2- In the adulthood few studies dealt with newly acquiring effect a pet in adults, as among 6292 adults, the risk of being sensitized to cat and developing symptoms when near cats was significantly higher than in who newly acquired a pet cat, especially kept cats in bedroom (Olivieri *et al*, 2012). The risk of becoming sensitized was highest in those who already sensitized to other allergens and those with pre-existed allergic diseases, such as asthma, allergic rhinitis, or eczema owned a cat in childhood was protective against sensitization acquired in adulthood (Liccardi *et al*, 2012). AlShatti and Ziyab (2020) in Kuwait found that houses pet-keeping was very common with diverse behavior and pet was positively associated with allergic symptoms, and that birds were the most common pets among families with children, followed by cats and rabbits, they showed associations with asthma, rhinitis, and eczema symptoms in adolescents.

Pet birds such as canaries, parakeets or parrots are not-common in urban areas, but common in rural ones are ducks, chicken pigeons, & geese; they are carriers and/or vectors of many zoonotic infectious diseases.

1- Bacterial diseases as Lyme disease (Olsen *et al*, 1996), zoonotic salmonellosis (Wells *et al*, 2001), campylobacteriosis (Wedderkopp *et al*, 2003), zoonotic tuberculosis (Lahuerta *et al*, 2009), chlamydophilosis (Circe-lla *et al*, 2011), and others gram-negative bacteria (Williams *et al*, 2011).

2- Viral diseases: as Avian influenza H₅N₁ wild indigenous birds to pet birds (Tully,

2009), West Nile Fever (Carboni *et al*, 2008), African mosquito-borne flavivirus of Usutu virus (Chvala *et al*, 2004), frequently fatal periventricular dilation disease (PDD) to aviculture (Doneley *et al*, 2007), Newcastle disease, caused by avian paramyxovirus (Pearson and McCann, 1975) especially pigeons and mechanically transmitted by *Musca domestica*, house-fly (Barin *et al*, 2010).

3- Parasitic/fungal diseases: Such as zoonotic toxoplasmosis (Rifaat *et al*, 1989), zoonotic giardiasis (Filippich *et al*, 1998), zoonotic cryptococcosis mainly pigeons and parrots (Brilhante *et al*, 2010), canaries, budgerigars or lovebirds, and cockatiels (Lugarini *et al*, 2008), zoonotic cryptosporidiosis (Quah *et al*, 2011) to infants & children (Farthing, 2000), and aspergillosis (Cray, 2011). Khalil *et al*. (2011) examined migratory brown necked raven, *Corvus r. ruficollis* trapped in the Suez Canal Zone detected parasites in descending order were: *C. parvum*, *E. histolytica*, *Sarcocystis* spp., *Hymenolepis* spp., *Giardia muris*, *Ascaridia galli*, *Eimeria* spp., *Fasciola* spp., *Heterakis gallinarum*, *A. lumbricoides*, *Spirometra* spp., *C. philippinensis*, *B. hominis*, *Clonorchis sinensis*, *Choanotaenia infundibulum* and *Isospora belli*.

Apart from zoonosis, pet birds may be as great an allergenic problem as cats and dogs, about 25 million them in the United States to cause allergic symptoms as nocturnal wheezy cough, asthma, rhinitis, conjunctivitis and others (Marks, 1984), where pet birds were the 4th most popular companion animal to keep as pet, after fish, cats, and dogs (Meyers, 1998). Friedmann and Thomas (2016) reported that in the United States, pet-birds can be a major source of comfort to some owners. But, in the EU, ornamental birds were the 3rd commonest pet without fish individual counting (Graham, 1998). Bener *et al*. (2004) in Qatar reported that the prevalence of asthma, rhinitis, and skin allergy was significantly more common in families' pets (cats; 26.7%, goats; 15% & birds; 14.7%) than in those families without.

Exposure impact: Assuming it is true that

early exposure to an animal can cause tolerance, an important question is that the tolerant response acquired by living in the presence of a pet requires ongoing exposure? Pets are an important source of health benefits to many families, but close contact with them, such as when they live in homes, can be associated with a variety of risks, including medically significant allergic diseases (Ownby and Johnson, 2016). In European Union, cat sensitization rate varied from 1.2 to 22.4% in general population mainly high in Nordic countries and lower in central/western and Mediterranean ones (Bousquet *et al*, 2007), and from 16.8 to 49.3% in patients (Heinzerling *et al*, 2009). Besides, longitudinal studies showed that pet sensitivity frequently increased in childhood and adolescents with peaks in youth (Asarnoj *et al*, 2016) or airborne allergy (Rönmark *et al*, 2017). Zano-betti *et al*. (2022) in USA used CREW cohorts, found that neighborhood characteristics at birth (higher population density and poverty) were associated with high risk of asthma but, without significant change between race or ethnicity, and asthma incidence. They added that black and Hispanic children were at high risk than white ones in asthma developing as race and ethnicity and neighborhood factors were associated with disease onset.

Confounding factors identified were given: There is a positive correlation between sensitization to cat or dog allergens and asthma but, this was not true in communities with very low rate of pet ownership (< 5%), as African-American communities in Georgia, as cat sensitivity was not significant with asthma (Carter *et al*, 2001). This might be due to exposure to animal allergens at school or in homes without a pet that was too low to induce sensitization (Svanes *et al*, 2006). Now families with a history of allergy tend to avoid keeping pets could confuse symptoms (Svanes *et al*, 2003). Evidence reported this fact in many European studies (Anyo *et al*, 2002). But, studies from the United States, New Zealand, and Sweden northern region, this behavior pattern was not always

found (Gereda *et al*, 2000). The behavior effects would only be relevant if children with an atopic family history were more likely to be sensitized if they lived without a pet cat. Thus, allergen exposure occurs mainly in households with pets, but can also happen at schools, nurseries, hospitals, and in public spaces (Sander *et al*, 2018). Menchetti *et al*. (2024) in Italy reported that in some communities, both dogs and cats are commonly kept outdoors, while in others, cats are more likely to be indoors, sometimes even exclusively. They concluded that the types of management strategies mainly depended on the owner's age, number of owned animals, and the dog size, as well as the sexual status and the cat breed, and allowed dogs and cats to sleep in their bedroom reported a stronger perceived bond with their animals.

Primary prevention: A meta-analysis reported that advice from health care practitioners to avoid or to specific acquire pets for primary asthma prevention or allergic rhinitis in children was not indicated (Lødrup *et al*, 2002). Pet dogs, cats, birds and even man bites are common worldwide and may be associated with significant morbidity (Morsy *et al*, 2021). Formerly, Pope *et al*. (1993) reported that Americans spend almost all time indoors in environments with increasingly airtight and often contain sources of allergens, such as dust mites, fungi, house pets, rodents, cockroaches, and certain chemicals. A patient can be referred for specific IgE antibodies to common seasonal and perennial inhaled allergens (Bousquet *et al*, 2012). A patient can ask an allergist for important allergens, such as animal dander, HDM, cockroach, if relevant, and others (Baldacci *et al*, 2015).

Besides, food allergy is an immune system reaction that happens soon after eating a certain food estimated to about 8% of children under age 5 and up to 4% of adults, in some cases, a food allergy can cause severe symptoms or even life-threatening anaphylaxis (Mayo Clinic, 2024). Also, there is food botulism (El-Bahnaway *et al*, 2014). Moreover, drug allergy encompasses a spectrum of im-

munologically mediated hypersensitivity reactions with various mechanisms and clinical presentations. This adverse drug reaction type not only affects patient quality of life, but also may lead to delayed treatment, unnecessary examinations, and increased morbidity and mortality (Jeimy *et al*, 2025).

The Ancient Egyptians kept wide animals variety of as pets, including cats, dogs, monkeys and birds, as well as more unusual pets; such as crocodiles, hippos and lions. The cat was particularly cherished and considered sacred, possibly linked to the Goddess Bastet. All pets were highly valued, and their deaths were often marked with mourning rituals similar to humans (Osypinska *et al*, 2021). However, the allergic diseases such as asthma and eczema were described in the Ancient Societies like Egypt, China and in the Greco-Roman culture (Ring, 2022). Death of Pharaoh Menes after a wasps' sting in 2600 BC was the first reported anaphylactic reaction (Wassermann, 2000). The Ancient Egyptians treated allergies with the many natural remedies, such as honey, herbs, and other substances were used in combination with the magical incantations. But, the honey was especially the popular ingredient, used for its antibacterial properties in wound salves and other remedies (Kapri *et al*, 2022).

Conclusion

Sensitization to cat and/or dog allergens is always associated with the asthma. Clinician must know whether living with cats or dogs increases or decreases the sensitization risk and whether this is consistently translated into a low risk disorder allergy is lacked.

Exposure to cats early in childhood causes lower sensitization rates (caused cat-specific IgE antibodies) to cat allergens, possible by inducing cat-specific tolerance, which is generally associated with IgG antibodies to cat allergens. This may be a result in highest levels of cat allergen exist with pet cats. But, exposure to dog in early childhood protects against asthma development and sensitivity to dog allergen and other allergens. So, a pet dog increases the density and/or diversity of

microbes present, and exposure to allergens in context of an array of microbes' products caused least sensitization rates.

However, it is not advice patients either to obtain a pet or remove an existing pet from the home for the sole purpose of reducing the risk of allergic disease in future children.

Patients with rhinitis or asthma symptoms and who are living in a house with a cat or a dog and are reluctant to remove the animal, an allergy evaluation is done to assess if they are sensitized to that animal, rather than empirically recommending pets' removal.

Apart from pet birds, the human communities often are an inadvertent source of food, water, and other resources to native and migratory species of wildlife. Controlling this introduced birds is a must by using a friendly environmental feasible control measure.

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Recommendations

For the health benefits of pets for families. Avoid petting, hugging and kissing pets or share sleeping with them. Regular brush and bathe pets with an environmental friendly insecticide outdoors are must. Daily vacuuming for the high-traffic areas, or every other day for medium-traffic areas, and twice weekly for least-traffic areas in order to have a clean and healthy home. Nevertheless, the personal hygiene is a must.

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