Allergy

WILEY

Allergy EUROPEAN JOURNAL OF ALLERGY AND CLINICAL IMMUNOLOGY EAACI

REVIEW OPEN ACCESS

Occupational Mite Allergy and Asthma: An EAACI Task Force Report

Hille Suojalehto[1] | Mohamed F. Jeebhay[2] | Ingrid Sander[3] | Santiago Quirce[4] | Susanne Vrtala[5] | Jolanta Walusiak-Skorupa[6] | Andreas L. Lopata[7] | Carmen Vidal[8] | Monika Raulf[3]

[1]Occupational Medicine, Finnish Institute of Occupational Health, Helsinki, Finland | [2]Occupational Medicine Division and Centre for Environmental & Occupational Health Research, University of Cape Town, Cape Town, South Africa | [3]Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Institute of the Ruhr-University Bochum (IPA), Bochum, Germany | [4]Department of Allergy, La Paz University Hospital, IdiPAZ, CIBER of Respiratory Diseases (CIBERES), Madrid, Spain | [5]Department of Pathophysiology and Allergy Research, Center for Pathophysiology, Infectiology and Immunology, Medical University of Vienna, Vienna, Austria | [6]Nofer Institute of Occupational Medicine, Department of Occupational Diseases and Environmental Health, Lodz, Poland | [7]Molecular Allergy Research Laboratory, College of Science and Engineering, Tropical Futures Institute-Singapore, James Cook University, Townsville, Australia | [8]Allergy Department, Faculty of Medicine USC, Complejo Hospitalario Universitario de Santiago, Santiago de Compostela, Spain

Correspondence: Hille Suojalehto (hille.suojalehto@ttl.fi)

Received: 19 March 2025 | **Revised:** 18 June 2025 | **Accepted:** 8 July 2025

Funding: This Task force report was supported by the European Academy of Allergy and Clinical Immunology (EAACI) under the EAACI OMAA Task Force, budget code 41009, 2023–2024.

Keywords: allergy | asthma | mites | occupational | rhinitis

ABSTRACT

Mite sensitization is notable in several occupational settings. Elevated house dust mite concentrations are primarily detected in workplaces where people congregate and are active. Allergy to storage mites and spider mites has commonly been reported in agricultural and various food processing occupations. Rapid expansion of biological pest control has resulted in increased exposure to predatory mites causing sensitization of greenhouse workers. Globally, mite populations in workplaces are likely to change due to climate change. Occupational relevant mites produce a variety of allergens and adjuvants that trigger both innate and adaptive immune responses. Cross-reactivity between allergens occurs due to shared IgE-binding epitopes to different allergens. Occupational allergy to mites typically causes rhinitis and asthma. Challenges of distinguishing the role of occupational exposure to allergens, also present in non-occupational environments, complicate the diagnosis of occupational mite allergy and asthma. Nevertheless, preventive measures to reduce exposure to mite allergens in workplaces are essential in mitigating occupational hazards. Further research is needed to better understand the incidence of occupational mite allergy and asthma. It is essential to identify the risk factors in different occupational settings, assess the impact of climate change on exposure, and determine the relevant allergens and their potential cross-reactivity.

Abbreviations: BAT, basophil activation test; EDC, electrostatic dust collector; FEIA, fluorescence enzyme immunoassay; HDM, house dust mite; IL, interleukin; MARIA, multiplex array for indoor allergens; MD-2, myeloid differentiation factor-2; OA, occupational asthma; OR, occupational rhinitis; PEF, peak expiratory flow; RAST, radioallergosorbent test; sIgE, specific Immunoglobulin E; SIT, specific allergen immunotherapy; SPT, skin prick test; Th, T-helper cell; TSLP, thymic stromal lymphopoietin.

1 | Introduction

Domestic mites are a major source of indoor allergens [1]. They include both house dust mites (HDMs), which feed mainly on dander, as well as storage mites, which feed on food or animal feed. In addition to homes, mites are also encountered in work environments, commonly related to farming and food production worldwide [2]. In recent decades, apart from domestic mites, spider mites, living on fruit leaves in gardens, greenhouses, and orchards [1], and predatory mites, widely used for biological pest control, represent an additional source of exposure [3].

An increasing number of studies have demonstrated a high prevalence of mite sensitization among workers in agricultural and food processing occupations [4–6]. These sensitized workers are at increased risk of airway symptoms. Several species have been identified to cause occupational rhinitis (OR) and/or occupational asthma (OA) [2]. Mite sensitization in these contexts constitutes a major occupational hazard that can result in significant clinical impairment among affected workers, including the ability to continue working in their current jobs.

The aims of the Occupational Mite Allergy and Asthma (OMAA) Task Force were to:

1. Develop an up-to-date position paper to summarize the current scientific evidence on the risks associated with mite exposure in occupational environments, with specific reference to OA and OR.
2. Conduct a comprehensive scoping narrative review on allergen sources, high-risk exposures in workplaces, identified allergens, and available diagnostic methods.
3. Provide a guidance note for the assessment, management, and prevention of OA and OR associated with mites in clinical practice.
4. Identify areas for future research.

2 | Methods

This document was prepared by the OMAA Task Force expert panel of allergologists, pneumologists, occupational medicine physicians, and scientists from several countries. The publication is the result of expert consensus opinion following a thorough review of the available literature.

2.1 | Data Sources, Search Strategy, and Study Selection

A literature search was conducted using Pubmed and Scopus. Key search items included (Mites *OR* acari) *AND* (Occupational allergy *OR* Occupational allergies *OR* work-related allergies *OR* Occupational asthma *OR* Work-related asthma *OR* Occupational Rhinitis *OR* Work-related Rhinitis *OR* Occupational conjunctivitis *OR* work-related conjunctivitis). No specific period was included in the search, but it was completed during the period 17–25 October 2023. There was a combined total of 684 articles, and after removing duplicates, a total of 552 articles were identified. Subsequently, seven articles/abstracts listed in the review by Baur and Bakehe (2014) [7] and 33 recommended by the Task Force team focusing mainly on exposure assessment studies were added, resulting in 592 articles. Articles were sorted by date (from the most recent) and were accepted for review if they were available in English. The articles were selected in a qualitative manner using the Population, Concept, and Context (PCC) framework. Articles were screened by title and abstract. Studies of occupational settings in epidemiological or clinical settings were included. Key concepts that formed the basis for inclusion were epidemiology, occupational causes (systematic reviews and meta-analysis, epidemiological studies, case reports, case series), specific exposure sources, exposure assessment, occupational allergens, mechanisms, clinical diagnosis, clinical management, and prevention. Non-occupational studies were excluded. This resulted in 215 articles that were identified as being suitable, which formed the basis for this scoping narrative review and expert opinion.

3 | Taxonomical Classification of Mites

More than 50,000 species of mites have been described. Mites belong to the Phylum Arthropoda (Subphylum Chelicerata), which is characterised by an exoskeleton (Figure 1). In contrast to insects, mites belong to the class Arachnida, characterised by four pairs of legs [8]. Mite species that cause occupational mite sensitisation and asthma belong to different orders and families. HDMs and storage mites belong to the order Astigmata. HDMs (Family: Pyroglyphidae) are mainly present in house dust, whereas storage mites, additionally found in workplaces related to farming and food production, belong to different families (Glycyphagidae, Acaridae, Echymyopodidae) [9]. However, the grouping according to the occurrence of mites is not consistent with the taxonomic classification. Predatory mites (Families: Phytoseiidae, Laelapidae) and poultry mites (Macronyssidae) belong to the order Mesostigmata. Predatory mites feed on spider mites and are often used for pest control, whereas poultry mites (Genus: *Ornithonyssus*) feed on blood, feathers, and skin of poultry [10]. Spider mites belong to the order Trombidiformes and the family Tetranychoidea (Genus: *Tetranychus, Panonychus*) and can be found on fruit leaves in greenhouses [11].

4 | Epidemiology and Risk Factors

4.1 | Epidemiology

A recent overview of systematic reviews indicated that there is moderate quality of evidence that the main group of mites and specifically the predatory-, spider-, and storage mites cause occupational mite sensitization, rhinitis, and asthma (Table 1) [1–2]. Earlier reviews reported limited or contradictory evidence for HDMs and poultry mites [7]. Dalboge et al. also concluded that there was moderate evidence for OA associated with mite exposures in farming and bakery occupations [2].

4.1.1 | House Dust Mites

There is increasing evidence that HDMs (*Dermatophagoides* spp. and *Blomia* spp.) can cause OA/OR. Several studies have reported sensitized workers and high levels of domestic mite allergens in

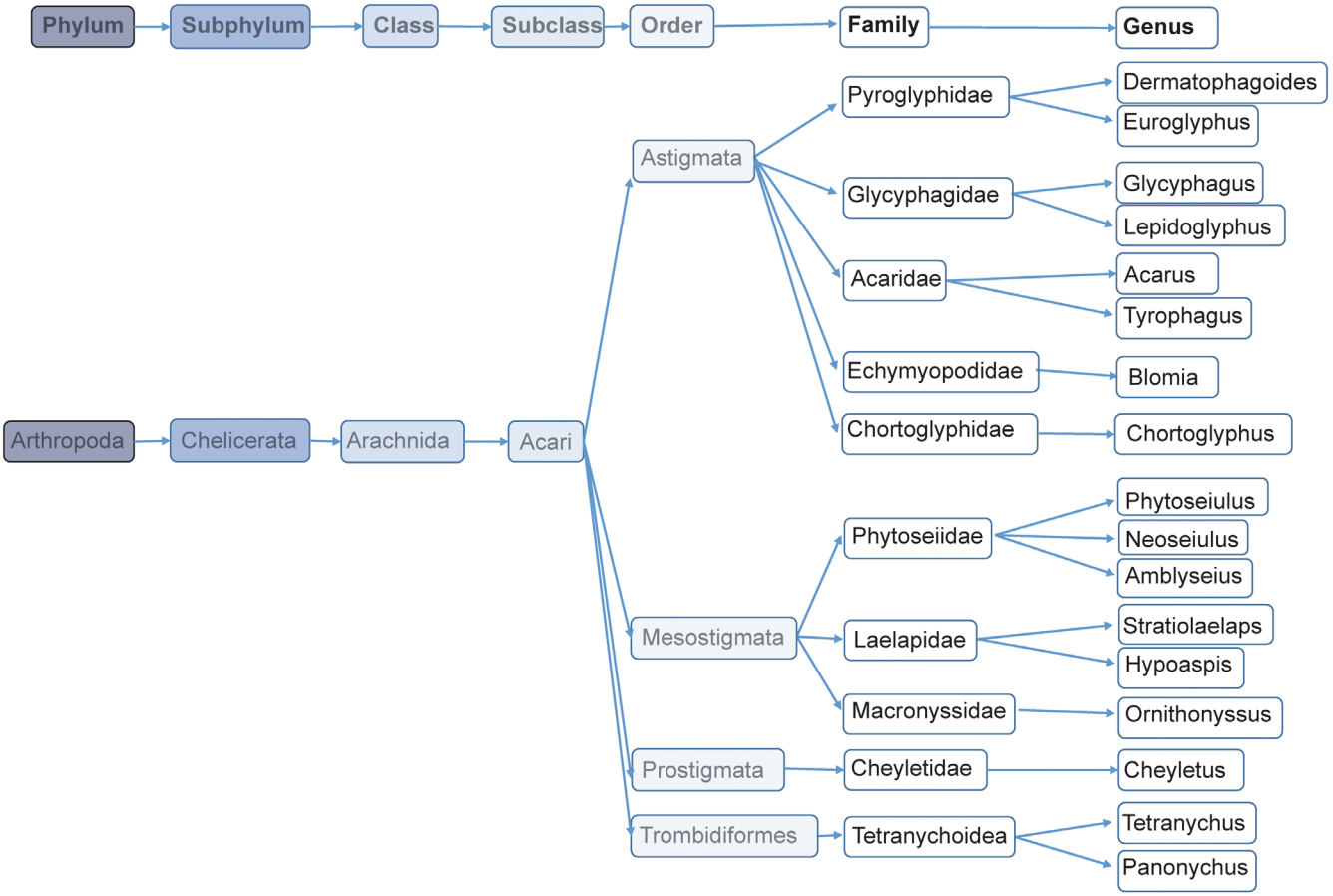

FIGURE 1 | Taxonomical classification of mites.

occupational settings, such as schools and day care centers, but clinically relevant exposures can also be found in other workplaces, including poultry farms and office environments [4, 63]. Due to their wide-scale preponderance, HDMs have been identified in various geographical locations globally and increasingly associated with certain workplace settings (Table 1).

4.1.2 | Storage Mites

The main species of storage mites that have been implicated in OA/OR *are Lepidoglyphus destructor, Acarus siro/farris, Tyrophagus putrescentiae*, and *Glycyphagus domesticus* (Table 1). Allergy to storage mites has been reported in various contexts, including occupations where hay and grain are handled, stored, or processed, such as agricultural workers, farmers, millers, and laboratory animal workers. Work in the food processing industry, such as bakers, ham, poultry, and dairy workers, has also been connected to OA/OR due to storage mites [40, 64–65]. A certain degree of moisture in the stored food (> 15%) plays a decisive role in the presence of storage mites and the sensitization of employees [34]. However, sensitization to storage mites has also been reported without occupational exposure in rural environments [65]. In some Northern European populations, sensitization to storage mite was as frequent as HDM sensitization [66]. While general urban populations have a typically lower prevalence of sensitization (< 10%) [66], levels are higher in certain occupational settings. Danish farmers had a sensitization prevalence of 17% [67], while another study reported changes over time, with sensitization increasing from 5% to 13% over a decade [68]. In studies of European bakers and grain handlers, sensitization varied between 11% and 33% [35, 66].

4.1.3 | Spider Mites

Spider mites are outdoor phytophagous mites living on fruit leaves. Commonly found in gardens, greenhouses, and orchards, these mites feed on a wide range of fruit trees, vines, berries, vegetables, and ornamental plants [1]. Multiple case reports and cross-sectional surveys have identified spider mites as significant allergens causing rhinitis and asthma among fruit farmers and greenhouse workers (Table 1) [7, 69]. The two-spotted spider mite (*Tetranychus urticae*) is prevalent in pear farms, greenhouses, and among herbaceous plants, while the European red mite (*Panonychus ulmi*) frequently infests apple orchards, and the citrus red mite (*Panonychus citri*) is typically found on citrus farms and orange groves [1, 21, 26]. *T. urticae* is also a notable outdoor allergen in table grape farm workers [11]. Furthermore, there appears to be a correlation between increased allergy risk to spider mites and high pesticide exposure among crop sprayers [11].

A meta-analysis and systematic review of twenty-three epidemiological studies of agricultural farming populations, assessing spider mite sensitization based on skin prick tests (SPT) or

TABLE 1 | List of mite species causing occupational allergy, rhinitis and asthma.

Mites (Acarina) species	Occupational exposure
Spider mites *(Tetranychidae)*	
Red spider mite *(Tetranychus urticae)*	Tomato greenhouse worker [12] Carnation greenhouse worker [13–14] Greenhouse workers [15–16] Greenhouse workers and open-field farmers [17–18] Flower cultivator [19] Table grape farm workers [11] Citrus farmers [20] Apple-cultivating farmers [21]
MacDaniel spider mite *(Tetranychus macdanieli)*	Vine growers [22]
European red mite *(Panonychus ulmi)*	Fruit tree workers [23] Apple-cultivating farmers [21, 24]
Citrus red mite (*Panonychus citri*)	Fruit tree workers [25] Citrus farmers [20, 26–27]
Storage mites *(Acaridae, Glycyphagidae)*	
Lepidoglyphus destructor	Farmers [9, 28–33] Arable farmworkers [34] Grain elevator workers [35] Grain-store workers [36] Grain workers [37–38] Grain miller [39] Bakers [40–42] Bakers, pastry factory workers, grain store workers and farmers [43] Thatcher [44] Grocery store workers [6] Dairy farmers [45–46] Poultry workers [47] Ham production workers [48] Laboratory animal workers [49]
Acarus siro	Farmers [9, 19, 32] Arable farmworkers [34] Grain elevator workers [35] Grain-store workers [36] Bakers [40–42] Thatcher [44] Grocery store workers [6] Dairy farmers [45] Food processing workers (cheese, chorizo, ham) [50] Ham production workers [48] Laboratory animal workers [49]
Acarus farris	Farm workers [32–33] Arable farmworkers [34] Grain-store workers [36]
Tyrophagus putrescentiae	Apple cultivating farmers [21] Farmers [9, 28, 31–32] Arable farmworkers [34] Grain elevator workers [35] Grain-store workers [36] Bakers [40–42] Thatcher [44] Grocery store workers [6] Dairy farmers [45–46] Food processing workers (cheese, chorizo, ham) [50] Ham production workers [48] Ham transport driver [51] Laboratory animal workers [49]
Tyrophagus longior	Farm workers [33]
Glycyphagus domesticus	Farmers [9, 28, 32] Arable farmworkers [34] Grain-store workers [36] Bakers [40, 42] Thatcher [44] Dairy farmers [45]
Thyreophagus entomophagus, Cheyletus eruditus	Farmers [32]
Storage mites (unspecified)	Cattle farmers [52]
Predatory mites *(Phytoseiidae)*	
Thrips mite *(Amblyseius cucumeris)*	Greenhouse workers [53] Gardener [54]
Amblyseius swirskii, Suidasia medanensis, Neoseiulus cucumeris	Greenhouse workers [15, 55–56]
Phytoseiulus persimilis, Hypoaspis miles	Greenhouse workers [55, 57–58]
House dust mites *(Pyroglyphidae)*	
Dermatophagoides pteronyssinus	Office workers [59] Poultry workers [47] Ham production workers [48] Farmers [19] Thatcher [44]
Dermatophagoides farinae	Office workers [60] Poultry workers [47] Ham production workers [48] Thatcher [44]

(Continues)

TABLE 1 | (Continued)

Mites (Acarina) species	Occupational exposure
Euroglyphus maynei	Food processing workers (cheese, chorizo, ham) [50]
Blomia tropicalis, Blomia tijbodas	Farmers [32]
Blomia kulagini	Farmers [32] Food processing workers (cheese, chorizo, ham) [50]
House dust mites (unspecified)	Office/Lab workers [61]
Poultry mites *(Macronyssidae)*	
Northern fowl mite (*Ornithonyssus sylviarum*)	Poultry workers [62]

Note: Updated from Baur et al. 2014 [7].

specific Immunoglobulin E (sIgE) measurements revealed a pooled sensitization prevalence of 22.9% (95% CI 19%–26.8%), and was as high as 43.9% (95% CI 35.1%–52.9%) when the analysis was restricted to symptomatic patient populations [5]. The study reported a global average monosensitization prevalence of 7% (95% CI 5%–9%), underlining the unique allergenic nature of spider mites. Pooled estimates indicate moderate prevalence of spider mite sensitization in agricultural populations, with subgroup prevalences of 27% (95% CI 20.5%–33.5%) for *T. urticae* and 18.2% (95% CI 12.4%–24.0%) for *P. citri* [5]. Therefore, agricultural workers, particularly those in fruit orchards and greenhouses, along with the surrounding rural population, are at increased risk of developing sensitization to spider mites.

4.1.4 | Predatory Mites

Predatory "beneficial" mites are increasingly being used for biological control in horticulture. The use of biological pest control has increased by 15% yearly in the past decade [3]. In contemporary times, predatory mites are also used to control plant pests in offices and other indoor environments. Predatory mites are mainly used in protected vegetable and ornamental cultivation systems to control phytophagous mites, thrips, and whiteflies. *Amblyseius swirskii*, *Phytoseiulus persimilis*, *Neoseiulus/Amblyseius cucumeris*, and *Neoseiulus/Amblyseius californicus* are the most commonly encountered species, accounting for approximately 60% of the entire arthropod biocontrol agent market. The sensitization prevalence to predatory mites among greenhouse workers varies between 15% and 52% (Table 1) [45, 53, 55, 57].

4.2 | Risk Factors

The risk factors associated with occupational allergy, rhinitis, and/or asthma due to mite exposures are presented in Table 2. Aside from host factors such as atopy, occupational risk factors such as high-risk jobs, as well as elevated, frequent, and prolonged mite exposures are the major determinants of risk. Inadequate ventilation and high humidity environments contribute to elevated mite allergen levels [64, 67, 70–72].

4.3 | Emerging Challenge of Climate Change

In the context of climate change and increasing environmental influences, it is likely that mite populations and their favored habitats will change. Global warming increases humidity, which may affect the growth and survival of mites, as the survival of domestic mites in particular is strongly dependent on humidity and temperature [73]. *B. tropicalis* needs high humidity levels (74%–80%), followed by *D. pteronyssinus* (60%–65%), and *D. farinae* (47%–50%). Lower winter temperatures associated with heated homes reduce *D. pteronyssinus* levels more than *D. farinae*, since the latter is more resistant to lower humidity and can survive periods of drought. Therefore, *D. farinae* is more common in homes in the northeastern regions of North America, northern Europe, and Korea. In addition to the geographical distribution and local dominance, mite metabolism could be influenced by climate change, possibly resulting in changes in the proportion and frequency of the proteins/allergens produced. Due to climate change trends, northward expansion and increasing spread of the phytophagous spider mite, *Tetranychus evansi* (tomato red spider mite) over time [74], should also be considered as an increase in allergic sensitization risk for agricultural workers.

5 | Allergen Sources and Exposure Assessment

There has been an increasing interest in evaluating exposure to mite allergens to initiate preventive measures following the 1964 discovery that mites in house dust were causing asthma. While the enumeration of microscopically identified mite species was used initially, the first EIAs (enzyme immunoassays) to estimate mite allergen exposure became available only in 1987. The most commonly used EIAs, even in workplaces, were based on monoclonal antibodies to major allergens (Der p 1, Der f 1, Der p 2 and Der f 2) of the HDMs *D. pteronyssinus* and *D. farinae* [47, 59, 75–80]. The samples collected were mainly reservoir dust obtained through vacuuming surfaces such as mattresses or floors. Single allergen specific EIAs of airborne dust samples were often not sensitive enough for allergen detection [81]. This was due to the fact that allergen-bearing particles from decomposing mite bodies or their faecal pellets, being relatively large, settle rapidly to the ground in a room where there is no activity and therefore do not remain airborne for long periods of time. Furthermore, since more than 30 mite allergens per species and several major allergens have been identified, single-allergen-specific EIAs can only detect a small percentage of mite allergens in dust, which is generally below the detection limit.

In the past two decades, more sensitive assays have been developed that are based on the same monoclonal antibodies for HDM allergens using amplification by polymeric enzyme-conjugates and detection by fluorescence (FEIA, fluorescence enzyme immunoassay). Fluorescence is also used for detection of indoor allergens (MARIA, Multiplex array for indoor allergens) in the

TABLE 2 | Risk factors for occupational allergy, rhinitis, and asthma associated with mites.

Occupational	Individual (host associated)
High-risk jobs involving exposure to organic dust, mouldy material stored under damp conditions, decomposing organic feed, enclosed agricultural settings with infested plants *Exposure to high levels of mite allergens* present in dusty environments or use of predatory mites in enclosed greenhouses *Prolonged duration or repeated exposure* to mites contributing to increasing cumulative exposures to mite allergens Work environments with *high humidity* levels and *poor ventilation* *Inadequate or improper use* of appropriate *respiratory protective equipment* for certain tasks (e.g., biological pest control operators)	*Atopic* or pre-existing sensitisation to mites (e.g., domestic exposures) Pre-existing *bronchial hyperresponsiveness* Pre-existing *occupational rhinitis* with ongoing exposures increase OA risk Pre-existing sensitisation to *tropomyosin or other cross-reactive allergens* from other sources (e.g., shellfish)

multiplex array, since it detects several different individual allergens simultaneously [82–84]. However, this improved sensitivity was still unable to determine mite allergens using passive samplers in schools [85]. As an alternative and supplement to the monoclonal antibody-based EIAs, radioallergosorbent test (RAST) inhibition or polyclonal rabbit antibodies to mite extracts have also been used for assay development [81, 86–88]. Since numerous allergens and antigens are recognized, detection is often successful even for airborne dust samples. In addition, development of these assays is simpler and faster. For some mite species especially relevant for the workplace, EIAs are not yet available, and detection is still done by counting the microscopically identified mites [86, 89–91].

Prior to quantification by microscopic or immunological methods, on-site sampling is required, ranging from collection of reservoir dusts directly or by vacuuming to collect dust samples [88]. An intermediate position is occupied by passive collection of settled dust using electrostatic dust collectors (EDC). Table 3 summarizes the original studies from the last 25 years in which mites or allergen concentrations were determined in dust samples from various workplaces. Due to differences in sampling and quantification methods, comparison of results between studies is challenging. A comparison of the mite allergen load between the workplace and the living area enables a crude estimation of exposure. While the HDM load tends to be rather low in offices and schools, it can reach relatively high levels in day care centers and home sleeping areas. Most floor dusts from US schools were below the detection limit for Der p 1 and Der f 1 in MARIA, containing a maximum of 0.78 μg/g and 1.64 μg/g respectively [83–84]. EDC samples from Dutch schools also remained below the detection limit for these individual allergens in MARIA [85]. Domestic mite allergens in these samples reached a geometric mean of 133 ng/m^2/week, while samples from German day-care centers had a median of 367 ng/m^2/week, which was even higher than samples collected from households at the same time (248 ng/m^2/week) [95].

The major allergen Der p 1 also reaches relatively high levels in poultry houses in Croatia (mean 0.78 μg/g) as well as in homes in the same region. Special workplaces, such as textile recycling, are more significantly contaminated by domestic mite allergens [93]. Several storage mite species of the *Acaridae*, *Glycyphagidae*, and *Chortoglyphidae* families have been identified in samples from barns, pigsties, cowsheds, poultry houses, and farm buildings [89–90]. On average, 3–30 *Acarus siro* mites, 1–13 *Lepidoglyphus destructor* mites, and 2–8 *Glycyphagus domesticus* mites per gram were counted in samples from barns and stables in Poland [90].

6 | Mechanisms of Mite Allergy and Asthma

Unique attributes of mites have allowed them to colonise indoor and outdoor environments, producing an unparalleled diversity of allergens and adjuvants, perfectly complemented to elicit both innate and adaptive immune reactions [100]. For example, mites contain several proteases, contained primarily in mite feacal particles but also in shed mite exoskeletons and decaying mite body fragments, which can affect epithelial membrane integrity including the breaching of tight junctions directly or activate protease-activated receptors [101] and has homology with the lipopolysaccharide-binding component of the Toll-like receptor 4 [102]. These intrinsic activities of some mite allergens stimulate key innate immune responses in the skin or airway epithelium leading to the release of proinflammatory cytokines and innate alarmins. Mite allergens (including the three major serodominant allergens Der p 1, 2 and 23) are found in both faecal pellets and mites' bodies so that continuous exposure to these allergens triggers the development of allergic reactions, commonly immediate type-I hypersensitivity reactions [1, 102–103].

7 | Clinical Manifestations

The clinical manifestations of occupational mite allergy are primarily OR [104] and OA [105–106], which have the potential to impair workers' quality of life and work ability. In addition, mite allergy may manifest with ocular symptoms and present as a conjunctivitis. Mites have not been documented as triggers of anaphylaxis in the European Anaphylaxis Registry (personal communication Prof. Margaritta Worm).

Typically, the natural progression after sensitization begins with rhinitis, characterised by nasal congestion, sneezing, and itching (sometimes accompanied by conjunctival symptoms), which is a strong predictor of subsequent asthma [107]. OA manifests as wheezing, breathlessness, and chest tightness

TABLE 3 | Studies of mite allergen exposure assessment conducted in occupational settings during the past two decades.

Sampling location	Method for allergen or species quantification	Samples/material	Sample numbers	Publication year
Bakeries, farms, silos, stables, Spain	Microscopic counting: *Dermatophagoides pteronyssinus, Dermatophagoides farinae, Lepidoglyphus destructor, Tyrophagus putrescentiae, Blomia tropicalis, Blomia kulagini, Acarus siro, Corthoglyphus arquatus, Glycyphagus domesticus, Euroglyphus maynei*	Reservoir: settled floor dust	10	1997 [89]
Cowsheds, pigsties, barns, chaff-cutter buildings, poultry houses, Poland	Microscopic counting: *Acarus siro, Glycyphagus domesticus, Acarus farris, Lepidoglyphus destructor, Acarus immobilis, Tyrophagus putrescentiae, Lepidoglyphus michaeli, Chortoglyphus arcuatus*, Cheyletidae	Reservoir: debris and litter	60	2019 [90]
Pig farms, grain mills, Germany	EIA: Lep d 2, Der p 1, Der f 1, Der 2	Reservoir: settled dust, vacuumed floor	approx. 500	2000 [92]
Cattle stables, Germany	EIAs: *Acarus siro, Lepidoglyphus destructor, Tyrophagus putrescentiae, Dermatophagoides pteronyssinus*, Der p 1	Passive sampling: EDC	24	2011 [87]
Poultry farms, Croatia	EIA: Der p 1	Reservoir: floor and surface dust	17	2010 [47]
Textile recycling, feather bed filling and cleaning, carpet cleaning, schools	FEIA: Domestic mite, EIA: Der f 1, Der p 1	Reservoir: vacuumed floor dust	147	2012 [81]
Textile recycling, cattle stables, feather bed filling, carpet cleaning, slaughterhouse, Germany		Airborne dust	76	
Textile recycling, Germany	FEIA: Domestic mite	Airborne dust	26	2019 [93]
Day care centres, US	Microscopic counting: *Dermatophagoides pteronyssinus, Dermatophagoides farinae, Blomia tropicalis, Cheyletus malaccensis*, Mesostigarnata, Oribatida	Reservoir: settled dust, vacuumed floor	20	2001 [86]
	EIA: Der p 1, Der f 1	Reservoir: settled dust, vacuumed floor	20	
	RAST inhibition, reference extract of *Dermatophagoides pteronyssinus*	Airborne dust	40	
Day care centres, US	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor	86	2005 [78]

(Continues)

TABLE 3 | (Continued)

Sampling location	Method for allergen or species quantification	Samples/material	Sample numbers	Publication year
Day care centres, Germany	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor and furniture	143	2002 [76]
Day care centres, Germany	FEIA: Domestic mite	Reservoir: vacuumed floor dust, upholstered furniture	1340	2016 [94]
Day care centres, Germany	FEIA: Domestic mite	Passive sampling: EDC	620	2018 [95]
Child care centres, Singapore	MARIA: Der p 1, EIA: Blo t 5	Reservoir: vacuumed floor	123	2008 [82]
Day care centres, Schools, Norway	EIA: Der p 1	Reservoir: vacuumed floor and furniture	> 81, > 155	2005 [96]
Schools, day care centres, US	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor and furniture	204	2009 [80]
Schools, Sweden	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor and furniture, clothes	48	1998 [75]
Schools, Sweden	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor and furniture	46	2007 [79]
Schools, Korea		Passive sampling: Petri dishes	68	
Schools, US	MARIA: Der p 1, Der f 1, Der 2	Reservoir: vacuumed floor and furniture	443	2017 [84]
Schools, Netherlands	FEIA: Domestic mite, MARIA: Der f 1, Der p 1	Passive sampling: EDC	117	2014 [85]
Schools, US	MARIA: Der p 1, Der f 1, Der 2	Reservoir: vacuumed floor and furniture	229	2012 [83]
		Airborne dust	118	
Schools, offices, Italy	EIA: Der p 1, Der f 1, Der 2	Reservoir: vacuumed floor and furniture	161	2009 [61]
Offices, US	EIA: Der p 1, Der f 1	Reservoir: settled dust, vacuumed floor	251	2005 [77]
Offices, archives, Italy	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor and chairs	160	2004 [97]

(Continues)

TABLE 3 | (Continued)

Sampling location	Method for allergen or species quantification	Samples/material	Sample numbers	Publication year
Offices, Canada	EIA: Der p 1, Der f 1	Reservoir: vacuumed floor, sieved dust	214	1998 [59]
Offices, Germany	FEIA: Domestic mite	Passive sampling: EDC	436	2022 [98]
		Reservoir: vacuumed floor dust	437	
Laboratory, offices, Italy	EIA: Der p 1, Der f 1, Der 2	Reservoir: vacuumed floor and furniture	60	2009 [99]
Offices, day-care centres, schools, hospitals, shop, bakery, canteen, bus, archive, cowshed, Finland	Microscopic counting: Acaridae, Tarsonemidae Tydeidae	Reservoir: water damaged surfaces	50	2007 [91]

symptoms that often worsen with continued exposure to allergens.

As is the case with other sensitizers, a period of repeated allergen exposure before the onset of symptoms is required. Nevertheless, given that mite exposure may occur in multiple exposure contexts, and since workers are not typically evaluated for mite sensitization prior to commencing employment, it is possible that pre-existing IgE sensitization may exist, resulting in a reduced latency period for manifestation of work-related symptoms.

With regard to OA caused by mites, making the diagnosis can prove challenging due to the potential presence of mites in other locations. With the exception of predator mites and spider mites, other mite species are not principally workplace sensitizers, and patients can become symptomatic due to prolonged exposure at home. However, if mite allergens are found in higher concentrations in occupational rather than domestic settings, patients are likely to experience worsening of their respiratory symptoms in the workplace [1].

8 | Diagnostic Approaches

The optimal diagnostic approach for occupational allergy and asthma is to integrate the comprehensive clinical history with objective diagnostic tests [108–109]. The latter should include evidence of work-related airway responses, including peak expiratory flow (PEF), non-specific bronchial hyperresponsiveness, and fractional exhaled nitric oxide (FeNO), where appropriate. Furthermore, evidence of specific sensitization, including SPT, sIgE, and possibly basophil activation test (BAT), is an important test to identify causes of the allergic symptoms. These elements are further supported by specific nasal [110] and conjunctival allergen provocation tests [111], and specific inhalation challenge, which is considered the reference standard for OA [112].

8.1 | Skin Prick Tests and Specific IgE Using Mite Extracts

A few manufacturers have developed standardized extracts for SPTs to detect sensitization to common house dust and storage mites. Unfortunately, these tests are not available for several mite species implicated in occupational allergy (Table 1). Therefore, in-house generated extracts for both SPTs and sIgE determinations would be required to test for most cases of occupational allergy. To our knowledge, *D. pteronyssinus and farinae, Euroglyphus maynei, A. siro, L. destructor, B. tropicalis, T. putrescentiae*, and *Chortoglyphus arcuatus* extracts are currently available in Europe, but not in all countries, and the ongoing regulatory process and economic reasons could hinder their production in the future.

Although many companies offer extracts for SPTs for *Dermatophagoides* species, considerable batch-to-batch variations have been detected. Besides, some important allergens may be underrepresented or completely lacking [113]. Additionally, extracts contain a mixture of species-specific and cross-reactive allergens, which makes it difficult to determine

the disease-eliciting allergen source. It may often be impossible to distinguish between sensitization caused by mite exposure at work and sensitization at home.

The same applies to sIgE determination of *Dermatophagoides* species, *A. siro, B. tropicalis, L. destructor, T. putrescentiae, G. domesticus*, *and E. maynei, which* can be measured using the ImmunoCAP platform (ThermoFisher Scientific) and Immulite 3G Allergy (Siemens), while Hycor and EuroImmun only offer sIgE measurements for *Dermatophagoides* species and MacroArray Diagnostics for *A. siro* and *T. putrescentiae*.

8.2 | Molecular Diagnosis and Allergens Identified

Several mite allergens have been identified and characterized (www.allergen.org), the majority derived from *D. farinae and pteronyssinus, B. tropicalis, T. putrescientiae, and L. destructor* (Table 4). During the past decade, the use of individual natural purified or recombinant allergens for the diagnosis of mite allergy has increased tremendously. Table 4 provides a complete list of registered allergens and categorizes them based on their biochemical function. Some of these mite allergens are used in singleplex IgE assays or in multiplex assays (macroarrays) that contain a variety of individual allergens from different allergen sources [114–115]. As for the molecular diagnosis of allergen components, only Der p/f 1, Der p/f 2, Der p 10, Der p 23, Lep d 2, and Blo t 5 can be determined on the ISAC platform. ImmunoCAP can be used for Der p 1, Der p 2, Der p 10, Der p 23, Lep d 2, and Blo t 5. The ALEX platform can be used for Gly d 2, Lep d 2, Tyr p 2, Blo t 5, Blo t 10, Blo t 21, and a more complete panel for *Dermatophagoides* species (1, 2, 5, 7 10, 11, 20, 21 and 23). Other platforms do not have sIgE reactants for molecular diagnosis. Individual allergens are only available for storage mites and HDMs of the species *Dermatophagoides* [116].

Testing with individual allergens may distinguish between cross- and co-sensitization. Furthermore, the use of species-specific allergens may also enable the identification of the mite species responsible for OA/OR in a patient. A thorough understanding of the molecular sensitization profile could be useful in identifying markers of workplace exposure, but knowledge gaps in this area remain. Zakzuk et al. recently reported a higher prevalence of IgE sensitization to Blo t 21 and Blo t 5 in asthma patients than in non-asthmatics in Colombia, while Blo t 2 was the most common sensitizer in exposed subjects [117]. This study did, however, not specifically focus on occupational allergy.

Cross-reactivity between allergens occurs because of shared similar IgE-binding epitopes between different allergens. These shared epitopes in close or distantly related mite species can lead to the development of allergic reactions. Cross-reactivity between different mite species has been demonstrated, in particular for the well characterized group 10 and 20 allergens, with their tropomyosin and arginine kinase homologues, sometimes implicated with other arthropod sensitization as detailed below. In addition, several other cross-reactivities have been partially confirmed [118]. The paramyosin allergen from *B. tropicalis* (Blo t 11) has been shown to cross-react with sera of subjects infected with *Ascaris lumbricoides* [119]. Recent studies among the group 2 allergens [120] (NPC2 family) however identified limited cross-reactivity of Blo t 2 with Der p 2 and Der f 2 [121]. The mature protein Blo t 2 has only 52% sequence identity to Der p 2 and up to 50% unique IgE-epitopes but was clinically relevant as demonstrated in 34% binding in a large cohort of mite allergic patients from Singapore. While nine natural occurring isoforms of Blo t 2 were identified, each having less than 3 amino acid variations, only two demonstrated significant IgE binding. This limited cross-reactivity between some mite species due to the major group 2 allergens, and possible species-specific sensitization, may lead to underdiagnosis and ineffective management.

A series of allergens have been characterised from different storage mite species, but only the cross-reactive tropomyosin has been characterised from the poultry mite, *Ornithonyssus sylviarum* (www.allergome.org). Being one of the most common cross-reactive allergens, tropomyosin is found in invertebrates, including shrimp, molluscs, mites, mosquitoes, and helminths [122]. Cross-reactivity has also been demonstrated between *Blomia* and food allergens from crustacean (Pen m 13) and oyster (Cra g 1) [122]. Furthermore, tropomyosin is a somatic antigen of the helminth *Ascaris lumbricoides*, which has been reported to be a primary cause of sensitization to HDM (*Blomia* spp.) in endemic tropical regions. Several IgE-binding components have also been detected in extracts from spider mites (*T. urticae*) or citrus red mites (*Panynychus citri*), but these allergens have not been characterised any further [123–124].

9 | General Approach to Clinical Management and Prevention

9.1 | Clinical Management at the Individual Level

The management of a patient with OA or OR associated with mite exposure includes environmental interventions based on the outcome of immunological tests of exposed workers. This is primarily aimed at avoiding or reducing exposure to the offending agent, timely pharmacological treatment, assessment of impairment, and optimizing rehabilitation and compensation. Making an early diagnosis is essential for a favorable outcome in the case of OA [125]. Removal from exposure, where possible, is the intervention of choice [126]. Where this is not possible, for example, when there is cross-reactivity between mites or food products, exposure reduction is an alternative. Exposure avoidance for HDM when it is identified as the primary cause may be difficult given the ubiquity of HDM in domestic and certain workplace settings.

In individuals with IgE-mediated OA, specific allergen immunotherapy (SIT) [127] may be a useful option when validated extracts are available, as is the case for HDM allergy. A short- and a long-term beneficial effect of SIT in occupational mite allergy, rhinitis, and asthma while the patient remained at work has not been reported. SIT has not been approved for routine management of mite allergy due to storage mites, spider mites, nor predator mites. This is due to the lack of commercially validated extracts for the latter two and very little evidence of clinical efficacy for storage mites.

Patients with co-existent arthropod or food-related OA/OR should practice both dietary and environmental avoidance.

TABLE 4 | Mite allergens—categorized according to their biochemical function (www.allergen.org).

Allergen group	Biochemical name	Allergen	MW (kDa)
1	Cysteine protease	Blo t 1, Der f 1, Der m 1, Der p 1, Eur m 1, Tyr p 1	25–39
2	NPC2 family; MD-2-related lipid recognition (ML) domain containing protein	Blo t 2, Der f 2, Der m 2, Der p 2, Eur m 2, Gly d 2, Lep d 2, Tyr p 2	14.5–16
3	Trypsin-like serin protease	Blo t 3, Der f 3, Der p 3, Eur m 3, Tyr p 3	23.8–26
4	Alpha-amylase	Blo t 4, Der f 4, Der p 4, Eur m 4, Tyr p 4	56–58
5	Lipid binding protein	Blo t 5, Der f 5, Der p 5, Lep d 5	~12.5–14
6	Chymotrypsin-like serine protease	Blo t 6, Der f 6, Der p 6	25
7	Lipid binding protein, Bactericidal permeability-increasing like protein	Blo t 7, Der f 7, Der p 7, Lep d 7, Tyr p 7	22–25
8	Glutathione S-transferase	Blo t 8, Der f 8, Der p 8, Tyr p 8	26–27
9	Trypsin-like serine protease, Collagenase like serine protease	Blo t 9, Der f 9, Der p 9	27
10	Tropomyosin	Blo t 10, Cho a 10, Der f 10, Der p 10, Lep d 10, Tyr p 10	33–42
11	Paramyosin	Blo t 11, Der f 11, Der p 11, Tyr p 11	98–110
12	Peritrophin-A-like domain containing protein	Blo t 12	14
13	Cytosolic fatty acid-binding protein	Aca s 13, Blo t 13, Der f 13, Der p 13, Lep d 13, Tyr p 13	14, 6–15
14	Apolipophorin	Eur m 14	177
15	Chitinase	Der f 15, Der p 15	58.8, 61.4
16	Gelsolin/villin	Blo t 16, Der f 16, Der p 16	53–55
17	Calcium binding protein	Der f 17, Der p 17	53
18	Chitinase-like protein (contains a C-terminal peritrophin-A-like domain)	Blo t 18, Der f 18, Der p 18	49–60
19	Anti-microbial peptide homologue	Blo t 19	7
20	Arginine kinase	Der f 20, Der p 20, Tyr p 20	40
21	Lipid binding protein	Blo t 21, Der f 21, Der p 21	13–15
22	NPC2 family; MD-2-related lipid recognition (ML) domain containing protein	Der f 22	14.7
23	Peritrophin-A-like protein	Der f 23, Der p 23	8, 19
24	Ubiquinol-cytochrome c reductase binding protein; Cytochrome b-c1 complex subunit 7	Blo t 24, Der f 24, Der p 24	13–14
25	Triosephosphate isomerase	Der f 25, Der p 25	27–34
26	Myosin light chain	Blo t 26, Der f 26, Der p 26	14–22
27	Serpin serine protease inhibitor	Blo t 27, Der f 27, Der p 27	44–48
28	Heat shock protein Hsp70	Blo t 28, Der f 28, Der p 28, Tyr p 28	45–76
29	Peptidyl-prolyl cis-trans isomerase (cyclophilin)	Der f 29, Der p 29	15–28
30	Ferritin	Blo t 30, Der f 30, Der p 30	12–20
31	Cofilin	Blo t 31; Der f 31, Der p 31, Tyr p 31	15–17
32	Inorganic pyrophosphatase	Blo t 32, Der f 32, Der p 32, Tyr p 32	33–35

(Continues)

TABLE 4 | (Continued)

Allergen group	Biochemical name	Allergen	MW (kDa)
33	Alpha-tubulin	Der f 33, Der p 33	44–53
34	Rid-like protein; enamine/imine deaminase	Der f 34	16
	Troponin C	Tyr p 34	18
35	NPC2 family; MD-2-related lipid recognition (ML) domain containing protein	Der f 15	14
		Tyr p 35	4
	Aldehyde dehydrogenase		52
36	C2 domain-containing protein	Der f 36, Der p 36	23
	Profilin	Tyr p 36	14
37	Chitin binding protein (contains 2 peritrophin-A-like domains)	Blo t 37, Der f 37, Der p 37	19
38	Bacteriolytic enzyme	Der f 38	15
39	Troponin C	Der f 39	18
40	Thioredoxin like protein	Der f 40	12
41	Putative chitin-binding protein (contains a peritrophin-A-like domain)	Blo t 41	14
42	Na/K-exchanging ATPase beta-subunit	Der f 42	36
43	Peroxiredoxin 1	Der f 43	27
44	Peroxiredoxin 2	Der f 44	25

Note: Allergen names and species: Aca s, *Acarus siro*; Blo t, *Blomia tropicalis*; Cho a, *Chortoglyphus arcuatus*; Der f, *Dermatophagoides farinae*; Der m, *Dermatophagoides microceras*; Der p, *Dermatophagoides pteronyssinus*; Eur m, *Euroglyphus maynei*; Gly d, *Glycyphagus domesticus*; Lep d, *Lepidoglyphus destructor*; Try p, *Tyrophagus putrescentiae*.

Workers who have had a previous anaphylactic reaction should be subjected to strict environmental control and surveillance, as well as provided with a written emergency management plan, an adrenaline auto-injector after being educated on its use.

9.2 | Preventive Approaches at the Workplace Level

OA/OR due to specific mites in an occupational setting is preventable through adequate assessment and management of risk factors (Table 2). Workplace occupational health risk assessments are key and should include establishing the degree of exposure, prioritizing the risks, and evaluating the effectiveness of existing allergen control measures [63]. Primary prevention through elimination of exposure to known sensitizing agents may not be possible unless they are introduced in a controlled manner as part of the work process. Removal of mite allergen reservoirs (e.g., vacuuming for HDM) is an effective way to reduce mite allergen exposure. A Cochrane review found that there was little evidence of clinical benefit of using mechanical ventilation with dehumidifiers alone for dehumidification in domestic environments [128]. Hence, a combination of cleaning, dehumidification or air conditioning, and appropriate food storage in very damp climates is advised [1]. Where HDMs are implicated, allergen avoidance measures such as limiting or replacing soft furnishings or using non-upholstered furnishings, adequate ventilation, and reducing the level of humidity could be used to reduce antigen concentrations [63]. In greenhouses, changes to work methods have been shown to reduce exposure to dust, which could reduce exposure to mite allergens [129]. Furthermore, environmental measurements could be used to evaluate whether controls are working. The utilization of chemical agents to reduce mite levels is generally not recommended.

Since specific exposure standards for various mites do not exist, keeping exposure as low as reasonably possible using appropriate risk management and exposure control strategies is advocated. Strategies for reducing exposure to the causal mite agent/s are specific to the industry and may include better organization of work, modification of food storage practices, working techniques that minimize dust production, mechanization or enclosure of processes, improving ventilation, short-term use of personal protective devices (e.g., respirators) while performing work tasks with the highest exposures, and general improvement of workplace conditions.

High-risk workers should undergo regular medical surveillance for early detection of OR/OA. This could include symptom questionnaires, lung function, and SPT/sIgE levels where appropriate. Medical surveillance, especially of workers exposed to specific mite allergens, should be prioritized in the first 2–3 years of exposure since OR/OA occurs more frequently during this period [130]. Atopic workers should not be excluded from occupations at risk due to the low positive predictive value of atopy for the development of OR/OA as well as other ethical considerations.

BOX 1 | Unmet needs and future research.

Future research that would enable a better understanding of occupational allergy and asthma to mites should focus on:

- Epidemiological studies to better understand the incidence of occupational mite allergy and asthma and their risk factors among workers in diverse occupational exposure settings.
- Understanding the association between pesticide exposure and increased risk of mite allergy, as well as the impact of mite allergens on different demographic groups, including rural residents.
- Quantifying storage mite allergens using standardised sampling methods in different workplaces and climatic regions and comparing the levels in residential environments from these areas.
- Epidemiological and experimental research to enhance the understanding of climate change factors on occupational mite exposure and allergy/asthma risk. This research can contribute to exposure prevention (including control measures) and medical surveillance programmes.
- Elucidating the mechanism of interactions between mite allergens and adjuvants to better understand the innate and adaptive immune responses.
- Understanding the cross-reactivity patterns between mites found in occupational and domestic settings.
- Considering cross-reactivity between inhaled mite allergens and ingested shellfish allergens.
- Characterising the molecular profiles in relation to clinical outcomes such as OR and OA.
- Identification and characterisation of major and minor species-specific allergens causing occupational mite allergy is a prerequisite for ensuring the availability of allergen extracts for component-resolved diagnostics.
- Understanding the progression from rhinitis to asthma associated with occupational mite exposure. The focus should be on both individual susceptibility and environmental factors, using job-exposure matrices to estimate risks. Additionally, identifying risk factors and refining diagnostic criteria for occupational mite-induced asthma.
- Studies aiming at development of immunotherapy for storage, spider and predatory mites.

Finally, workers should be educated on various aspects including improved work practices to reduce exposure, the role of mite allergens in causing acute and chronic symptoms as well as compliance with treatment, where appropriate.

10 | Conclusions

In this taskforce report, the current scientific evidence on the health risks associated with mite exposure in occupational environments was reviewed with specific reference to allergen sources, high-risk exposures in workplaces, identified allergens, and available diagnostic methods. Furthermore, a guidance note for the assessment, management, and prevention of OA and OR in clinical practice is provided.

Further studies are needed to understand the incidence of occupational mite allergy and asthma, the risk factors for diverse occupational settings, climate change factors influencing exposure and health risk, as well as the identification of the major allergens of relevant mite species, their biological non-IgE-mediated activities, and their cross-reactivity (Box 1).

Author Contributions

All authors contributed to the conceptualization of the work. H.S., M.J., M.R., I.S., S.Q., S.V., A.L.L., and C.V. contributed to writing the first draft of the manuscript. All authors have read and agreed to the published version of the manuscript.

Acknowledgements

We thank Zahida Sonday of the Occupational Medicine Division in the School of Public Health and Dilshad Brey of the Bongani Mayosi Library of the Faculty of Health Sciences at the University of Cape Town for performing the literature search. Open access publishing facilitated by Tyoterveyslaitos, as part of the Wiley - FinELib agreement.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

References

1. M. Sánchez-Borges, E. Fernandez-Caldas, W. R. Thomas, et al., "International Consensus (ICON) on: Clinical Consequences of Mite Hypersensitivity, a Global Problem," *World Allergy Organization Journal* 10, no. 1 (2017): 14.

2. A. Dalbøge, H. Albert Kolstad, C. S. Ulrik, et al., "The Relationship Between Potential Occupational Sensitizing Exposures and Asthma: An Overview of Systematic Reviews," *Annals of Work Exposures and Health* 67, no. 2 (2023): 163–181.

3. M. Knapp, Y. van Houten, E. van Baal, and T. Groot, "Use of Predatory Mites in Commercial Biocontrol: Current Status and Future Prospects," *Acarologia* 58 (2018): 72–82.

4. J. Macan, B. Kanceljak-Macan, and S. Milković-Kraus, "Pyroglyphid Mites as a Source of Work-Related Allergens," *Arhiv za Higijenu Rada i Toksikologiju* 63, no. 1 (2012): 57–66.

5. Y. Zhou, H. Jia, X. Zhou, Y. Cui, and J. Qian, "Epidemiology of Spider Mite Sensitivity: A Meta-Analysis and Systematic Review," *Clinical and Translational Allergy* 8 (2018): 21.

6. T. Koistinen, P. Ruoppi, T. Putus, S. Pennanen, A. Harju, and J. Nuutinen, "Occupational Sensitization to Storage Mites in the Personnel of a Water-Damaged Grocery Store," *International Archives of Occupational and Environmental Health* 79, no. 7 (2006): 602–606.

7. X. Baur and P. Bakehe, "Allergens Causing Occupational Asthma: An Evidence-Based Evaluation of the Literature," *International Archives of Occupational and Environmental Health* 87, no. 4 (2014): 339–363.

8. M. J. Colloff, "Taxonomy and Identification of Dust Mites," *Allergy* 53, no. 48 (1998): 7–12.

9. M. van Hage-Hamsten, S. G. Johansson, S. Höglund, P. Tüll, A. Wirén, and O. Zetterstrom, "Storage Mite Allergy Is Common in a Farming Population," *Clinical Allergy* 15, no. 6 (1985): 555–564.

10. G. M. Beretta, J. A. Deere, G. J. Messelink, K. Muñoz-Cárdenas, and A. Janssen, "Review: Predatory Soil Mites as Biocontrol Agents of Above- and Below-Ground Plant Pests," *Experimental & Applied Acarology* 87, no. 2 (2022): 143–162.

11. M. F. Jeebhay, R. Baatjies, Y. S. Chang, et al., "Risk Factors for Allergy due to the Two-Spotted Spider Mite (*Tetranychus urticae*) Among Table Grape Farm Workers," *International Archives of Allergy and Immunology* 144, no. 2 (2007): 143–149.

12. A. R. Erlam, A. J. Johnson, and K. N. Wiley, "Occupational Asthma in Greenhouse Tomato Growing," *Occupational Medicine (London)* 46, no. 2 (1996): 163–164.

13. J. Delgado, E. Gómez, J. L. Palma, et al., "Occupational Rhinoconjunctivitis and Asthma Caused by Tetranychus Urticae (Red Spider Mite). A Case Report," *Clinical & Experimental Allergy* 24, no. 5 (1994): 477–480.

14. J. Delgado, J. C. Orta, A. M. Navarro, et al., "Occupational Allergy in Greenhouse Workers: Sensitization to Tetranychus Urticae," *Clinical and Experimental Allergy* 27, no. 6 (1997): 640–645.

15. H. Suojalehto, P. Hölttä, S. Suomela, T. Savinko, I. Lindström, and K. Suuronen, "High Prevalence of Sensitization to Mites and Insects in Greenhouses Using Biologic Pest Control," *Journal of Allergy and Clinical Immunology. In Practice* 9, no. 11 (2021): 4130–4137.

16. A. M. Navarro, J. Delgado, M. C. Sanchez, et al., "Prevalence of Sensitization to Tetranychus Urticae in Greenhouse Workers," *Clinical and Experimental Allergy* 30, no. 6 (2000): 863–866.

17. C. Astarita, A. Franzese, G. Scala, S. Sproviero, and G. Raucci, "Farm Workers' Occupational Allergy to Tetranychus Urticae: Clinical and Immunologic Aspects," *Allergy* 49, no. 6 (1994): 466–471.

18. C. Astarita, D. Gargano, F. Manguso, et al., "Epidemiology of Allergic Occupational Diseases Induced by Tetranychus Urticae in Greenhouse and Open-Field Farmers Living in a Temperate Climate Area," *Allergy* 56, no. 12 (2001): 1157–1163.

19. A. Cisteró-Bahima, E. Enrique, R. Alonso, M. del Mar San Miguel, and B. Bartolomé, "Simultaneous Occupational Allergy to a Carnation and Its Parasite in a Greenhouse Worker," *Journal of Allergy and Clinical Immunology* 106, no. 4 (2000): 780.

20. E. Burches, A. Pelaez, C. Morales, et al., "Occupational Allergy due to Spider Mites: Tetranychus Urticae (Koch) and Panonychus Citri (Koch)," *Clinical and Experimental Allergy* 26, no. 11 (1996): 1262–1267.

21. Y. K. Kim, M. H. Lee, Y. K. Jee, et al., "Spider Mite Allergy in Apple-Cultivating Farmers: European Red Mite (*Panonychus ulmi*) and Two-Spotted Spider Mite (*Tetranychus urticae*) may Be Important Allergens in the Development of Work-Related Asthma and Rhinitis Symptoms," *Journal of Allergy and Clinical Immunology* 104, no. 6 (1999): 1285–1292.

22. M. Carbonnelle, F. Lavaud, and R. Bailly, "Les Acariens de la Vigne Sont-Ils Susceptibles de Provoquer Une Allergie Respiratoire?," *Revue Française d Allergologie et d Immunologie Clinique* 26, no. 4 (1986): 171–178.

23. R. Kroidl, H. J. Maasch, and R. Wahl, "Respiratory Allergies (Bronchial Asthma and Rhinitis) due to Sensitization of Type I Allergy to Red Spider Mite (Panonychus Ulmi KOCH)," *Clinical and Experimental Allergy* 22, no. 10 (1992): 958–962.

24. F. B. Michel, J. J. Guin, C. Seignalet, et al., "Panonychus Ulmi Allergy (Proceedings)," *Acta Allergologica* 32, no. 3 (1977): 217.

25. T. Ashida, T. Ide, S. Tabata, et al., "IgE-Mediated Allergy to Spider Mite, Panonychus Citri in Occupationally Exposed Individuals," *Arerugī* 44, no. 11 (1995): 1290–1296.

26. Y. K. Kim, J. W. Son, H. Y. Kim, et al., "Citrus Red Mite (*Panonychus citri*) is the Most Common Sensitizing Allergen of Asthma and Rhinitis in Citrus Farmers," *Clinical and Experimental Allergy* 29, no. 8 (1999): 1102–1109.

27. Y. K. Jee, H. S. Park, H. Y. Kim, et al., "Two-Spotted Spider Mite (Tetranychus Urticae): An Important Allergen in Asthmatic Non-Farmers Symtomatic in Summer and Fall Months," *Annals of Allergy, Asthma & Immunology* 84, no. 5 (2000): 543–548.

28. O. D. Cuthbert, J. Brostoff, D. G. Wraith, and W. D. Brighton, "'Barn Allergy': Asthma and Rhinitis due to Storage Mites," *Clinical Allergy* 9, no. 3 (1979): 229–236.

29. M. van Hage-Hamsten, E. Ihre, O. Zetterström, and S. G. Johansson, "Bronchial Provocation Studies in Farmers With Positive RAST to the Storage Mite Lepidoglyphus Destructor," *Allergy* 43, no. 8 (1988): 545–551.

30. M. van Hage-Hamsten, S. G. Johansson, S. Höglund, P. Tüll, and O. Zetterström, "Occurrence of Allergy to Storage Mites and IgE Antibodies to Pollens in a Swedish Farming Population," *European Journal of Respiratory Diseases* 154 (1987): 52–59.

31. M. Iversen, T. Hallas, J. Korsgaard, and R. Dahl, "A One-Year Case Study of Farmers With Storage Mite Allergy," *Journal of Investigational Allergology & Clinical Immunology* 2, no. 1 (1992): 9–14.

32. H. Müsken, J. T. Franz, R. Wahl, et al., "Sensitization to Different Mite Species in German Farmers: Clinical Aspects," *Journal of Investigational Allergology & Clinical Immunology* 10, no. 6 (2000): 346–351.

33. O. D. Cuthbert, I. G. Jeffrey, H. B. McNeill, J. Wood, and M. D. Topping, "Barn Allergy Among Scottish Farmers," *Clinical Allergy* 14, no. 2 (1984): 197–206.

34. A. D. Blainey, M. D. Topping, S. Ollier, and R. J. Davies, "Respiratory Symptoms in Arable Farmworkers: Role of Storage Mites," *Thorax* 43, no. 9 (1988): 697–702.

35. P. Revsbech and G. Andersen, "Storage Mite Allergy Among Grain Elevator Workers," *Allergy* 42, no. 6 (1987): 423–429.

36. A. D. Blainey, M. D. Topping, S. Ollier, and R. J. Davies, "Allergic Respiratory Disease in Grain Workers: The Role of Storage Mites," *Journal of Allergy and Clinical Immunology* 84, no. 3 (1989): 296–303.

37. C. P. Warren, V. Holford-Strevens, and R. N. Sinha, "Sensitization in a Grain Handler to the Storage Mite Lepidoglyphus Destructor (Schrank)," *Annals of Allergy* 50, no. 1 (1983): 30–33.

38. M. Garcés Sotillos, J. Blanco Carmona, and S. Juste Picón, "Late Asthma Caused by Inhalation of Lepidoglyphus Destructor," *Annals of Allergy* 67, no. 2 Pt 1 (1991): 126–128.

39. M. J. Alvarez, R. Castillo, A. Rey, N. Ortega, C. Blanco, and T. Carrillo, "Occupational Asthma in a Grain Worker due to Lepidoglyphus Destructor, Assessed by Bronchial Provocation Test and Induced Sputum," *Allergy* 54, no. 8 (1999): 884–889.

40. B. H. Mbatchou Ngahane, E. Afane Ze, F. Nde, E. Ngomo, Y. Mapoure Njankouo, and L. R. Njock, "Prevalence and Risk Factors for Allergic Rhinitis in Bakers in Douala, Cameroon," *BMJ Open* 4, no. 8 (2014): e005329.

41. P. Revsbech and M. Dueholm, "Storage mite allergy among bakers," *Allergy* 45, no. 3 (1990): 204–208.

42. B. H. Mbatchou Ngahane, F. Nde, E. Ngomo, and E. Afane Ze, "Sensitization to Workplace Respiratory Allergens Among Bakery Workers in Douala, Cameroon: A Cross-Sectional Study," *Allergy, Asthma & Clinical Immunology* 11, no. 1 (2015): 13.

43. A. Armentia, J. Tapias, D. Barber, et al., "Sensitization to the Storage Mite Lepidoglyphus Destructor in Wheat Flour Respiratory Allergy," *Annals of Allergy* 68, no. 5 (1992): 398–403.

44. D. Vieluf, B. Przybilla, X. Baur, and J. Ring, "Respiratory Allergy and Atopic Eczema in a Thatcher due to Storage and House Dust Mite Allergy," *Allergy* 48, no. 3 (1993): 212–214.

45. M. Kronqvist, E. Johansson, G. Pershagen, S. G. Johansson, and M. van Hage-Hamsten, "Increasing Prevalence of Asthma Over 12 Years Among Dairy Farmers on Gotland, Sweden: Storage Mites Remain Dominant Allergens," *Clinical and Experimental Allergy* 29, no. 1 (1999): 35–41.

46. E. O. Terho, K. Husman, I. Vohlonen, M. Rautalahti, and H. Tukiainen, "Allergy to Storage Mites or Cow Dander as a Cause of Rhinitis Among Finnish Dairy Farmers," *Allergy* 40, no. 1 (1985): 23–26.

47. D. Rimac, J. Macan, V. M. Varnai, et al., "Exposure to Poultry Dust and Health Effects in Poultry Workers: Impact of Mould and Mite Allergens," *International Archives of Occupational and Environmental Health* 83, no. 1 (2010): 9–19.

48. F. Tafuro, E. Ridolo, M. Goldoni, M. Montagni, A. Mutti, and M. Corradi, "Work-Related Allergies to Storage Mites in Parma (Italy) ham Workers," *BMJ Open* 5, no. 5 (2015): e007502.

49. P. Ruoppi, T. Koistinen, and S. Pennanen, "Sensitisation to Mites in Laboratory Animal Workers With Rhinitis," *Occupational and Environmental Medicine* 62, no. 9 (2005): 612–615.

50. A. Armentia, A. Fernández, C. Pérez-Santos, et al., "Occupational Allergy to Mites in Salty Ham, Chorizo and Cheese," *Allergologia et Immunopathologia* 22, no. 4 (1994): 152–154.

51. P. Rodriguez del Rio, J. I. Tudela Garcia, N. J. Narganes, E. Fernández-Caldas, V. Rodríguez-Garcia, and J. Subiza, "Occupational Asthma Caused by the Inhalation of Tyrophagus Putrescentiae Allergens in a Dry-Cured Ham Transporter Allergic to Shrimp," *Journal of Investigational Allergology & Clinical Immunology* 22, no. 5 (2012): 383–384.

52. V. Patussi, S. Mazzucato, A. Lorusso, et al., "Storage Mites and Their Role in the Onset of Asthma and Oculorhinitis Among Cattle Farmers in North-East Italy," *La Medicina del Lavoro* 85, no. 5 (1994): 402–411.

53. G. C. Groenewoud, C. Graaf Veld, A. J. van Oorschot Nes, et al., "Prevalence of Sensitization to the Predatory Mite Amblyseius Cucumeris as a New Occupational Allergen in Horticulture," *Allergy* 57, no. 7 (2002): 614–619.

54. S. G. Skousgaard, T. Thisling, C. Bindslev-Jensen, and J. Baelum, "Occupational Asthma Caused by the Predatory Beneficial Mites Amblyseius Californicus and Amblyseius Cucumeris," *Occupational and Environmental Medicine* 67, no. 4 (2010): 287.

55. J. Bælum, M. B. Kærstad, A. Enkegaard, P. S. Skov, G. Doekes, and T. Sigsgaard, "Health Effects of Predatory Beneficial Mites and Wasps in Greenhouses Pesticides. In: Copenhagen, Denmark: Danish Environmental Protection Agency," (2007).

56. I. Lindström, H. Karvonen, K. Suuronen, and H. Suojalehto, "Occupational Asthma From Biological Pest Control in Greenhouses," *Journal of Allergy and Clinical Immunology. In Practice* 6, no. 2 (2018): 692–694.

57. E. Johansson, B. Kolmodin-Hedman, E. Källström, L. Kaiser, and M. van Hage-Hamsten, "IgE-Mediated Sensitization to Predatory Mites in Swedish Greenhouse Workers," *Allergy* 58, no. 4 (2003): 337–341.

58. M. Kronqvist, E. Johansson, B. Kolmodin-Hedman, H. Oman, M. Svartengren, and M. van Hage-Hamsten, "IgE-Sensitization to Predatory Mites and Respiratory Symptoms in Swedish Greenhouse Workers," *Allergy* 60, no. 4 (2005): 521–526.

59. D. Menzies, P. Comtois, J. Pasztor, F. Nunes, and J. A. Hanley, "Aeroallergens and Work-Related Respiratory Symptoms Among Office Workers," *Journal of Allergy and Clinical Immunology* 101, no. 1 (1998): 38–44.

60. D. Menzies, J. Pasztor, F. Nunes, J. Leduc, and C. H. Chan, "Effect of a New Ventilation System on Health and Well-Being of Office Workers," *Archives of Environmental Health* 52, no. 5 (1997): 360–367.

61. B. Brunetto, B. Barletta, S. Brescianini, et al., "Differences in the Presence of Allergens Among Several Types of Indoor Environments," *Annali dell'Istituto Superiore di Sanità* 45, no. 4 (2009): 409–414.

62. S. Bar-Sela, H. Teichtahl, and I. Lutsky, "Occupational Asthma in Poultry Workers," *Journal of Allergy and Clinical Immunology* 73, no. 2 (1984): 271–275.

63. D. O. Matuka, E. Ratshikhopha, and T. Singh, "House-Dust Mites: Challenges With Establishing Causal Associations in Occupational Health for Ubiquitous Agents—A Retrospective Study," *Current Allergy & Clinical Immunology* 36, no. 2 (2023): 106–117.

64. M. F. Jeebhay, G. Moscato, B. E. Bang, et al., "Food Processing and Occupational Respiratory Allergy- An EAACI Position Paper," *Allergy* 74, no. 10 (2019): 1852–1871.

65. M. L. Marques, I. Rezende, I. Cunha, et al., "Allergic Sensitization to Storage Dust Mites: A Prospective Study of Patients With Respiratory Allergy," *European Annals of Allergy and Clinical Immunology* 54, no. 1 (2022): 43–47.

66. N. O. Jõgi, R. Kleppe Olsen, C. Svanes, et al., "Prevalence of Allergic Sensitization to Storage Mites in Northern Europe," *Clinical and Experimental Allergy* 50, no. 3 (2020): 372–382.

67. M. Iversen, J. Korsgaard, T. Hallas, and R. Dahl, "Mite Allergy and Exposure to Storage Mites and House Dust Mites in Farmers," *Clinical and Experimental Allergy* 20, no. 2 (1990): 211–219.

68. G. Elholm, V. Schlünssen, G. Doekes, et al., "Adult Farming Exposure Does Not Protect Against Sensitization to the Storage Mite Lepidoglyphus Destructor," *Allergy* 73, no. 11 (2018): 2234–2237.

69. Y. K. Kim and Y. Y. Kim, "Spider-Mite Allergy and Asthma in Fruit Growers," *Current Opinion in Allergy and Clinical Immunology* 2, no. 2 (2002): 103–107.

70. S. Van Heide, J. S. Van Zee, and J. G. De Monchy, "Allergic Sensitization to Biological Control Agents in Greenhouse Workers," *Clinical and Experimental Allergy* 27, no. 8 (1997): 984–990.

71. D. M. Roberts and A. L. Rees, "Occupational Asthma in Greenhouse Workers Associated With Spider Mites (Tetranychus Urticae)," *Occupational and Environmental Medicine* 71, no. 7 (2014): 490–495.

72. A. B. Bohadana, D. B. Teculescu, S. E. Megherbi, and Q. T. Pham, "Bronchial Hyperresponsiveness in Farmers: Relation to Respiratory Symptoms, Lung Function, and Atopy," *Lung* 177, no. 3 (1999): 191–201.

73. N. Acevedo, J. Zakzuk, and L. Caraballo, "House Dust Mite Allergy Under Changing Environments," *Allergy, Asthma & Immunology Research* 11, no. 4 (2019): 450–469.

74. W. Yan, L. Du, H. Liu, and G. Y. Li, "Current and Future Invasion Risk of Tomato Red Spider Mite Under Climate Change," *Journal of Economic Entomology* 117, no. 4 (2024): 1385–1395.

75. M. Berge, A. K. Munir, and S. Dreborg, "Concentrations of Cat (Fel d1), Dog (Can f1) and Mite (Der f1 and Der p1) Allergens in the Clothing and School Environment of Swedish Schoolchildren With and Without Pets at Home," *Pediatric Allergy and Immunology* 9, no. 1 (1998): 25–30.

76. S. Engelhart, T. Bieber, and M. Exner, "House Dust Mite Allergen Levels in German Day-Care Centers," *International Journal of Hygiene and Environmental Health* 205, no. 6 (2002): 453–457.

77. J. M. Macher, F. C. Tsai, L. E. Burton, and K. S. Liu, "Concentrations of Cat and Dust-Mite Allergens in Dust Samples From 92 Large US Office Buildings From the BASE Study," *Indoor Air* 15, no. 9 (2005): 82–88.

78. S. J. Arbes, M. Sever, J. Mehta, N. Collette, B. Thomas, and D. C. Zeldin, "Exposure to Indoor Allergens in Day-Care Facilities: Results From 2 North Carolina Counties," *Journal of Allergy and Clinical Immunology* 116, no. 1 (2005): 133–139.

79. J. L. Kim, L. Elfman, and D. Norbäck, "Respiratory Symptoms, Asthma and Allergen Levels in Schools–Comparison Between Korea and Sweden," *Indoor Air* 17, no. 2 (2007): 122–129.

80. D. C. Tranter, A. T. Wobbema, K. Norlien, and D. F. Dorschner, "Indoor Allergens in Minnesota Schools and Child Care Centers," *Journal of Occupational and Environmental Hygiene* 6, no. 9 (2009): 582–591.

81. I. Sander, E. Zahradnik, G. Kraus, et al., "Domestic Mite Antigens in Floor and Airborne Dust at Workplaces in Comparison to Living Areas: A New Immunoassay to Assess Personal Airborne Allergen Exposure," *PLoS One* 7, no. 12 (2012): e52981.

82. M. S. Zuraimi, T. C. Ong, K. W. Tham, and F. T. Chew, "Determinants of Indoor Allergens in Tropical Child Care Centers," *Pediatric Allergy and Immunology* 19, no. 8 (2008): 746–755.

83. P. Permaul, E. Hoffman, C. Fu, et al., "Allergens in Urban Schools and Homes of Children With Asthma," *Pediatric Allergy and Immunology* 23, no. 6 (2012): 543–549.

84. W. J. Sheehan, P. Permaul, C. R. Petty, et al., "Association Between Allergen Exposure in Inner-City Schools and Asthma Morbidity Among Students," *JAMA Pediatrics* 171, no. 1 (2017): 31–38.

85. E. J. Krop, J. H. Jacobs, I. Sander, M. Raulf-Heimsoth, and D. J. Heederik, "Allergens and β-Glucans in Dutch Homes and Schools: Characterizing Airborne Levels," *PLoS One* 9, no. 2 (2014): e88871.

86. E. Fernández-Caldas, R. Codina, D. K. Ledford, W. L. Trudeau, and R. F. Lockey, "House Dust Mite, Cat, and Cockroach Allergen Concentrations in Daycare Centers in Tampa, Florida," *Annals of Allergy, Asthma & Immunology* 87, no. 3 (2001): 196–200.

87. E. Zahradnik, I. Sander, B. Kendzia, C. Fleischer, T. Brüning, and M. Raulf-Heimsoth, "Passive Airborne Dust Sampling to Assess Mite Antigen Exposure in Farming Environments," *Journal of Environmental Monitoring* 13, no. 9 (2011): 2638–2644.

88. M. Raulf, J. Buters, M. Chapman, et al., "Monitoring of Occupational and Environmental Aeroallergens–EAACI Position Paper. Concerted Action of the EAACI IG Occupational Allergy and Aerobiology & Air Pollution," *Allergy* 69, no. 10 (2014): 1280–1299.

89. A. Armentia, A. Martinez, R. Castrodeza, et al., "Occupational Allergic Disease in Cereal Workers by Stored Grain Pests," *Journal of Asthma* 34, no. 5 (1997): 369–378.

90. K. Solarz and C. Pająk, "Risk of Exposure of a Selected Rural Population in South Poland to Allergenic Mites. Part II: Acarofauna of Farm Buildings," *Experimental & Applied Acarology* 77, no. 3 (2019): 387–399.

91. S. Pennanen, H. Mussalo-Rauhamaa, A. Harju, et al., "Exposure to Mites, Sensitisation and Allergy to Mites in Moisture Damaged Buildings," *Indoor and Built Environment* 16, no. 1 (2007): 19–27.

92. K. Radon, A. Schottky, S. Garz, et al., "Distribution of Dust-Mite Allergens (Lep d 2, Der p 1, Der f 1, Der 2) in Pig-Farming Environments and Sensitization of the Respective Farmers," *Allergy* 55, no. 3 (2000): 219–225.

93. I. Sander, S. Mayer, C. Brochwitz, C. Czibor, T. Brüning, and M. Raulf, "Gibt es eine erhöhte Allergenexposition bei der Alttextiliensortierung," *Allergo Journal* 28 (2019): 74.

94. I. Sander, H. D. Neumann, A. Lotz, et al., "Allergen Quantification in Surface Dust Samples From German Day Care Centers," *Journal of Toxicology and Environmental Health. Part A* 79, no. 22–23 (2016): 1094–1105.

95. I. Sander, A. Lotz, H. D. Neumann, et al., "Indoor Allergen Levels in Settled Airborne Dust Are Higher in Day-Care Centers Than at Home," *Allergy* 73, no. 6 (2018): 1263–1275.

96. C. Instanes, G. Hetland, S. Berntsen, M. Løvik, and P. Nafstad, "Allergens and Endotoxin in Settled Dust From Day-Care Centers and Schools in Oslo, Norway," *Indoor Air* 15, no. 5 (2005): 356–362.

97. L. Perfetti, M. Ferrari, E. Galdi, et al., "House Dust Mites (Der p 1, Der f 1), cat (Fel d 1) and Cockroach (Bla g 2) Allergens in Indoor Work-Places (Offices and Archives)," *Science of the Total Environment* 328, no. 1 (2004): 15–21.

98. I. Sander, A. Lotz, V. Liebers, et al., "Comparing the Concentration Levels of Allergens and Endotoxins in Employees' Homes and Offices," *International Archives of Occupational and Environmental Health* 95, no. 3 (2022): 573–588.

99. B. Brunetto, S. Brescianini, B. Barletta, et al., "Exposure to Indoor Allergens and Association With Allergy Symptoms of Employees in a Work Environment," *Annali dell'Istituto Superiore di Sanità* 45, no. 4 (2009): 415–422.

100. J. C. Vidal-Quist, F. Ortego, and P. Hernández-Crespo, "Contribution of Cysteine and Serine Proteases to Proteolytic Digestion in an Allergy-Eliciting House Dust Mite," *Journal of Insect Physiology* 133 (2021): 104285.

101. M. D. Chapman, S. Wünschmann, and A. Pomés, "Proteases as Th2 Adjuvants," *Current Allergy and Asthma Reports* 7, no. 5 (2007): 363–367.

102. J. D. Miller, "The Role of Dust Mites in Allergy," *Clinical Reviews in Allergy and Immunology* 57, no. 3 (2019): 312–329.

103. S. E. Wenzel, "Asthma Phenotypes: The Evolution From Clinical to Molecular Approaches," *Nature Medicine* 18, no. 5 (2012): 716–725.

104. M. Hytönen, L. Kanerva, H. Malmberg, R. Martikainen, P. Mutanen, and J. Toikkanen, "The Risk of Occupational Rhinitis," *International Archives of Occupational and Environmental Health* 69, no. 6 (1997): 487–490.

105. R. F. Kroidl, U. Schwichtenberg, and E. Frank, "Bronchial Asthma due to Storage Mite Allergy," *Pneumologie* 61, no. 8 (2007): 525–530.

106. J. P. Zock, N. Cavallé, H. Kromhout, et al., "Evaluation of Specific Occupational Asthma Risks in a Community-Based Study With Special Reference to Single and Multiple Exposures," *Journal of Exposure Analysis and Environmental Epidemiology* 14, no. 5 (2004): 397–403.

107. T. Storaas, S. K. Steinsvåg, E. Florvaag, A. Irgens, and T. B. Aasen, "Occupational Rhinitis: Diagnostic Criteria, Relation to Lower Airway Symptoms and IgE Sensitization in Bakery Workers," *Acta Oto-Laryngologica* 125, no. 11 (2005): 1211–1217.

108. C. M. Barber, P. Cullinan, J. Feary, et al., "British Thoracic Society Clinical Statement on Occupational Asthma," *Thorax* 77, no. 5 (2022): 433–442.

109. P. Cullinan, O. Vandenplas, and D. Bernstein, "Assessment and Management of Occupational Asthma," *Journal of Allergy and Clinical Immunology. In Practice* 8, no. 10 (2020): 3264–3275.

110. J. Augé, J. Vent, I. Agache, et al., "EAACI Position Paper on the Standardization of Nasal Allergen Challenges," *Allergy* 73, no. 8 (2018): 1597–1608.

111. J. L. Fauquert, M. Jedrzejczak-Czechowicz, C. Rondon, et al., "Conjunctival Allergen Provocation Test: Guidelines for Daily Practice," *Allergy* 72, no. 1 (2017): 43–54.

112. O. Vandenplas, H. Suojalehto, T. B. Aasen, et al., "Specific Inhalation Challenge in the Diagnosis of Occupational Asthma: Consensus Statement," *European Respiratory Journal* 43, no. 6 (2014): 1573–1587.

113. A. Casset, A. Mari, A. Purohit, et al., "Varying Allergen Composition and Content Affects the in Vivo Allergenic Activity of Commercial Dermatophagoides Pteronyssinus Extracts," *International Archives of Allergy and Immunology* 159, no. 3 (2012): 253–262.

114. K. H. Park, J. Lee, D. W. Sim, and S. C. Lee, "Comparison of Singleplex Specific IgE Detection Immunoassays: ImmunoCAP Phadia 250 and Immulite 2000 3gAllergy," *Annals of Laboratory Medicine* 38, no. 1 (2018): 23–31.

115. B. Keshavarz, T. A. E. Platts-Mills, and J. M. Wilson, "The Use of Microarray and Other Multiplex Technologies in the Diagnosis of

Allergy," *Annals of Allergy, Asthma & Immunology* 127, no. 1 (2021): 10–18.

116. H. J. Huang, E. Sarzsinszky, and S. Vrtala, "House Dust Mite Allergy: The Importance of House Dust Mite Allergens for Diagnosis and Immunotherapy," *Molecular Immunology* 158 (2023): 54–67.

117. J. Zakzuk, K. Donado, E. Mondol, et al., "IgE-Mediated Sensitization to Blo t 21 and Blo t 5 Is Associated With Asthma in the Tropics: A Case–Control Study," *Journal of Investigational Allergy and Clinical Immunology* 34, no. 3 (2024): 157–166.

118. W. R. Thomas, "IgE and T-Cell Responses to House Dust Mite Allergen Components," *Molecular Immunology* 100 (2018): 120–125.

119. G. R. Valmonte, G. A. Cauyan, and J. D. Ramos, "IgE Cross-Reactivity Between House Dust Mite Allergens and Ascaris Lumbricoides Antigens," *Asia Pacific Allergy* 2, no. 1 (2012): 35–44.

120. E. C. Liao, C. M. Ho, M. Y. Lin, and J. J. Tsai, "Dermatophagoides Pteronyssinus and Tyrophagus Putrescentiae Allergy in Allergic Rhinitis Caused by Cross-Reactivity Not Dual-Sensitization," *Journal of Clinical Immunology* 30, no. 6 (2010): 830–839.

121. K. Reginald, S. L. Pang, and F. T. Chew, "Blo t 2: Group 2 Allergen From the Dust Mite Blomia Tropicalis," *Scientific Reports* 9, no. 1 (2019): 12239.

122. S. D. Kamath, M. Bublin, K. Kitamura, T. Matsui, K. Ito, and A. L. Lopata, "Cross-Reactive Epitopes and Their Role in Food Allergy," *Journal of Allergy and Clinical Immunology* 151, no. 5 (2023): 1178–1190.

123. H. Y. Kim, H. S. Park, Y. K. Kim, et al., "Identification of IgE-Binding Components of Citrus Red Mite in Sera of Patients With Citrus Red Mite-Induced Asthma," *Journal of Allergy and Clinical Immunology* 107, no. 2 (2001): 244–248.

124. Y. K. Kim, S. Y. Oh, J. W. Jung, K. U. Min, Y. Y. Kim, and S. H. Cho, "IgE Binding Components in Tetranychus Urticae and Panonychus Ulmi-Derived Crude Extracts and Their Cross-Reactivity With Domestic Mites," *Clinical and Experimental Allergy* 31, no. 9 (2001): 1457–1463.

125. G. Rachiotis, R. Savani, A. Brant, S. J. MacNeill, A. Newman Taylor, and P. Cullinan, "Outcome of Occupational Asthma After Cessation of Exposure: A Systematic Review," *Thorax* 62, no. 2 (2007): 147–152.

126. O. Vandenplas, H. Dressel, D. Nowak, and J. Jamart, "What Is the Optimal Management Option for Occupational Asthma?," *European Respiratory Review* 21, no. 124 (2012): 97–104.

127. O. Pfaar, T. Ankermann, M. Augustin, et al., "Guideline on Allergen Immunotherapy in IgE-Mediated Allergic Diseases: S2K Guideline of the German Society of Allergology and Clinical Immunology (DGAKI), Society of Pediatric Allergology and Environmental Medicine (GPA), Medical Association of German Allergologists (AeDA), Austrian Society of Allergology and Immunology (ÖGAI), swiss Society for Allergology and Immunology (SSAI), German Dermatological Society (DDG), German Society of Oto-Rhino-Laryngology, Head and Neck Surgery (DGHNO-KHC), German Society of Pediatrics and Adolescent Medicine (DGKJ), Society of Pediatric Pulmonology (GPP), German Respiratory Society (DGP), German Professional Association of Otolaryngologists (BVHNO), German Association of Paediatric and Adolescent Care Specialists (BVKJ), Federal Association of Pneumologists, Sleep and Respiratory Physicians (BdP), professional Association of German Dermatologists (BVDD)," *Allergologie select* 6 (2022): 167–232.

128. M. Singh and N. Jaiswal, "Dehumidifiers for Chronic Asthma," *Cochrane Database of Systematic Reviews* 2013, no. 6 (2013): Cd003563.

129. A. M. Madsen, K. Tendal, and M. W. Frederiksen, "Attempts to Reduce Exposure to Fungi, β-Glucan, Bacteria, Endotoxin and Dust in Vegetable Greenhouses and a Packaging Unit," *Science of the Total Environment* 468 (2014): 1112–1121.

130. D. Fishwick, C. M. Barber, L. M. Bradshaw, et al., "Standards of Care for Occupational Asthma: An Update," *Thorax* 67, no. 3 (2012): 278–280.