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Review

PYROGLYPHID MITES AS A SOURCE OF WORK-RELATED ALLERGENS

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Pyroglyphid mites are primarily associated with allergen exposure at home; hence the name house dust mites. However, we have found numerous studies reporting pyroglyhid mite levels in public and occupational settings. This review presents the findings of house dust mite allergens (family *Pyroglyphidae*, species *Dermatophagoides*) as potential work-related risk factors and proposes occupations at risk of house dust mite-related diseases. Pyroglyphid mites or their allergens are found in various workplaces, but clinically relevant exposures have been observed in hotels, cinemas, schools, day-care centres, libraries, public transportation (buses, trains, taxies, and airplanes), fishing-boats, submarines, poultry farms, and churches. Here we propose a classification of occupational risk as low (occasional exposure to mite allergen levels up to 2 μg g^{-1}), moderate (exposure between 2 μg g^{-1} and 10 μg g^{-1}), and high (exposure >10 μg g^{-1}). The classification of risk should include factors relevant for indoor mite population (climate, building characteristics, and cleaning schedule). To avoid development or aggravation of allergies associated with exposure to house dust mites at work, occupational physicians should assess exposure risk at work, propose proper protection, provide vocational guidance to persons at risk and conduct pre-employment and periodic examinations to diagnose new allergy cases. Protection at work should aim to control dust mite levels at work. Measures may include proper interior design and regular cleaning and building maintenance.

KEY WORDS: *allergic diseases,* Dermatophagoides *species*, *Der f 1, Der p 1, indoor allergens, occupational exposure, work-related diseases*

Dust mites are an important source of potent allergens that can start a specific immunological reaction known as immunoglobulin E (IgE)-mediated allergic reaction or allergic reaction type I. This reaction is at the root of atopic diseases including atopic rhinitis, conjunctivitis, dermatitis, and asthma (1-3).

Even though experts are not unanimous about threshold allergen levels, they all acknowledge a dose-response relationship between dust mite allergen exposure and sensitisation and symptoms of related atopic diseases. However, 2 μg of dust mite allergen or 100 mites per gram of dust are commonly accepted as threshold levels for sensitisation in humans, while 10 μg of dust mite allergen or 500 mites per gram of dust are accepted as threshold levels for the occurrence of symptoms in already sensitised persons (1, 4, 5).

Therefore, monitoring exposure to dust mite allergens is an important part of the atopic diseases prevention. Over the years, several methods have been involved to measure dust mite allergen levels in various indoor dust samples. Historically the first method was the so called biological method with microscopic identification and scoring. Mites were usually separated from the dust using the flotation method (6) and were identified with identification keys

(7). As this method was time-consuming and required expertise in mite biology, new laboratory methods were developed to make the analysis easier. One such method was the Acarex test for semi-quantitative measurement of the guanine level in dust. Dust mites are the most important source of guanine in the dust and its level significantly correlates with the level of dust mites allergen (8). Besides, the method is inexpensive and easy to perform outside the laboratory; and is still used for screening indoor exposure to dust mites. For more precise monitoring however, today we use the two-site monoclonal antibody-based enzyme immunoassay (9), either as a standard quantitative laboratory method (10) or its quicker, semi-quantitative immunodot versions like Dustscreen, Aclotest, or Ventia (11-13).

The most common dust mites in households are from the *Pyroglyphidae* family, genera *Dermatophagoides* (*D. pteronyssinus*, *D. farinae*), hence the name "house dust mites". Allergy to these mites is frequent in asthmatic patients (45 % to 90 %) and correlates with exposure, which is greater in warmer climates that favour their growth (14-16). Levels of Der p 1 and Def f 1 (main allergens of *D. pteronyssinus* and *D.farinae*, respectively) increase from the north to the south European regions; in Scandinavian households they are virtually undetectable, while in Italy, Germany, Spain (16), and Croatia (17) they exceed the sensitisation threshold of 2 $\mu g\ g^{-1}$ of dust. In Croatia, however, only Der p 1 exceeds the sensitisation threshold, in coastal households in particular.

Unlike storage mites from the families *Acaridae* and *Glycyphagidae* that have been known as sources of occupational allergens since the early 20th century, mainly in agricultural workers (18, 19), pyroglyphid mites are primarily associated with allergen exposure at home. However, their levels have been increasingly monitored in public and occupational settings, and the aim of this review is to present house dust mite allergens as potential work-related risk factors and to propose occupations at risk of house dust mite-related diseases. Our study is based on articles included in the PubMed database that have investigated exposure to house dust mites (family *Pyroglyphidae*, species *Dermatophagoides*) in various public and occupational indoor environments. We limited the research to articles in English that measured exposure with the number of mites or their allergen levels (Der p 1 and/or Der f 1) in settled dust samples.

EXPOSURE TO HOUSE DUST MITES IN PUBLIC/OCCUPATIONAL SETTINGS

With the exception of house dust mite exposure in schools and day care centres, which are addressed further in the text, Table1 shows exposure levels to pyroglyphid mites in public places reported by 32 studies from all over the world. Exposure to pyroglyphid mites in offices reported by seven studies from Italy, USA, Canada, Brazil, China, and New Zealand (20-26) was generally below the sensitisation threshold. Two studies (20, 21) reported that up to 5 % of dust samples had allergen levels above the 2 $\mu g\ g^{-1}$, mostly from upholstered office chairs. Three studies established a correlation between higher mite allergen levels and carpeted floors (21, 23, 24).

Hospitals were explored for house dust mites in five studies from Germany, New Zealand, USA, UK, and Poland (24, 27-30) including dust samples from hospital beds. None observed exposure above the sensitisation threshold, even in bed dust samples.

In contrast, hotel rooms in Brazil and New Zealand (24, 31) were highly contaminated with house dust mites; most floor and bed dust samples had the allergen level above the 2 $\mu g\ g^{-1}$. In fact, Brazilian hotel dust samples had allergen levels above the threshold level for symptom development.

Similarly high exposure to pyroglyphid mites was found in Polish and US libraries (28, 32) and in New Zealand and UK cinemas (24, 33); most dust samples exceeded the sensitisation threshold. In Polish libraries, the main source of mites were bookshelves, books, and upholstered chairs. In the US study, clinically significant allergen levels were found only in school libraries of southern states with warmer and more humid climate. The main sources of dust mite allergens in cinemas were upholstered chairs, and their levels rarely exceeded the symptom threshold.

Exposure to pyroglyphid mites was also investigated in buses, trains, trams, taxies, and airplanes in New Zealand, Finland, UK, Japan, and Brazil (24, 34-37). In UK trains (35) and Finnish buses, trams, and trains (34) it was very low. In New Zealand airplanes it was also very low, with the exception of a few seat samples above the sensitisation threshold (24). In contrast, Brazilian buses and Japanese trains were highly contaminated with pyroglyphid mites, with most dust samples above the sensitisation threshold (36, 37).

Pyroglyphid mite allergen levels above the sensitisation and symptom thresholds were observed in the bed dust from fishing boats and submarines (38,

39) occupied over long periods of time (three weeks for fishing boats, and three months for submariners).

Animal facilities, including experimental laboratories, zoo cages, and pig and poultry farms studied in Germany, Poland, Finland, and Croatia showed generally low exposure to pyroglyphid mites (40-42), save for a few poultry farm samples exceeding the sensitisation threshold (43).

Pyroglyphid mites were not found in outdoor communal waste in Poland (44), nor in Finnish groceries (45). Dust samples from churches in New Zealand showed mite allergen levels above the sensitisation threshold (24).

Exposure to pyroglyphid mites in schools and day care centres was addressed in two recently published reviews (46, 47). They confirm the correlation between exposure above the sensitisation threshold and warm/humid climate. High allergen levels also correlated with dampness, carpeting, fabric-covered furniture, bedding, and soft toys, as well as with poor cleaning practice. However, even in these circumstances mite allergen levels rarely exceed the symptom threshold.

ASSESSMENT OF OCCUPATIONAL EXPOSURE TO HOUSE DUST MITES

Undoubtedly the main source of exposure to pyroglyphid mites and their allergens are our homes, our bedrooms in particular. The highest mite allergen levels were observed in mattresses, pillows, carpets, and other textile-covered parts of households furniture, curtains, tapestry, and fabric wallpapers (16, 46). Mite population density and the corresponding level of allergens depend significantly on feeding options and indoor temperature and humidity. Households usually provide optimal conditions as far as feeding and indoor temperature go, but humidity may greatly limit mite population growth. Most house dust mites cannot grow in relative humidity below 50 %, particularly in households using central heating systems (17). In addition to climate, mite growth is favoured by dampness, poor ventilation, fabric furnishing, and poor cleaning practice (16, 46, 48).

Even though our homes are the main sources of exposure to pyroglyphid mites, there is enough evidence that house dust mites are present in numerous public and/or occupational indoor environments (Table 1). Mites can be transferred to a public place or a workplace on the clothes (49-51), skin, or hair, and will form an active population if the new environment provides favourable feeding opportunities, temperature, and humidity. Fabric furnishing, poor ventilation, dampness, and poor cleaning practice only add to occupational exposure. According to all that, pyroglyphid mites or their allergens are found in various workplaces like hotels, cinemas, schools, day-care centres, libraries, offices, public transportation (buses, trams, trains, cars), airplanes, fishing-boats, submarines, poultry farms, churches, hospitals, zoo-gardens, experimental laboratories, groceries (Table 1) (20-47).

In the occupational environments that do favour mite growth, risk assessment should first establish if the level of exposure is above the sensitisation and symptom thresholds (4). This is why we propose that the risk be classified in three categories: low risk generally involves exposure to levels below the sensitisation threshold with occasional exposure above 2 $\mu g\ g^{-1}$ or 100 mites per gram of dust; moderate risk involves exposures generally between the sensitisation and symptom thresholds [(2 to 10) $\mu g\ g^{-1}$ or (100 to 500) mites per gram of dust]; and high risk exposure mainly above the symptom threshold (>10 $\mu g\ g^{-1}$ or >500 mites per gram of dust). Based on the presented literature, in Table 2 we propose occupations at risk for clinically relevant occupational exposure to pyroglyphid mites in temperate climate. This classification should reflect relevant indoor conditions that may significantly affect occupational exposure (16, 46-48).

Another issue is establishing the relation between occupational exposure to pyroglyphid mites and the diagnosed allergic disease (rhinitis, asthma, or dermatitis). In the majority of cases, people are sensitised to dust mites at home and develop related allergic diseases in the childhood or adolescence. Their condition can only get worse at moderate-to-high-risk workplaces with exposure above the symptom threshold (10 $\mu g\ g^{-1}$). This is where the occupational health service can help by providing vocational/pre-employment counsel to pupils, students, and workers with allergic disease caused by house dust mites (52).

On the other hand, there are cases when allergic diseases caused by dust mites occur in adulthood after employment at risk workplaces (such as those proposed in Table 2). In temperate climates, residential exposure to house dust mites is by far more common than occupational, but workplaces with moderate and high exposures to pyroglyphid mites could substantially

Table 1 *Studies investigating exposure to house dust mites in various occupational settings*

Study (reference number)	Sampling place	Method and number of samples	House dust mites number or allergen levels	Percent of samples above the sensitisation threshold*
Janko et al., 1995 (26) USA	Offices (14 offices)	ELISA	Der p 1: >1 μg g^{-1} in 4 offices	
Wickens et al., 1997 (24) New Zealand	Offices (banks)	ELISA 26 floor samples	Der p 1(IQR): (0.05 to 0.25)μg g^{-1}; GM 0.11 μg g^{-1}	None
Menzies et al., 1998 (22) Canada	Offices (from 6 office buildings)	ELISA Number of floor samples not presented	Der p 1 or Der f 1 levels ≥ 1 μg g^{-1} attributable for 8 % of work-related symptoms in exposed workers	
Graudenz et al., 2002 (23) Brazil	Offices (from 3 office buildings)	ELISA Number of floor samples not presented	Der p 1 and 2, Der f 1 and 2: Ranges: ND to 1.9 μg g^{-1}	None
Perfetti L et al., 2004 (20) Italy	Offices Bank archive	ELISA (Dustscreen™) 160 floor or chair samples, 41 from archive	Der p 1 (IQR): (0.05 to 0.25) μg g^{-1}; max. 19.5 μg g^{-1} Der f 1 (IQR): (0.05 to 0.41) μg g^{-1}; max. 77.5 μg g^{-1}	Der p 1: 5 % of samples Der f 1: 4 % of samples Mostly from upholstered chairs
Macher et al., 2005 (21) USA	Offices (from 92 office buildings)	ELISA 251 floor samples	Detectable levels of Der p 1 and Der f 1 in 78 % of samples	Der p 1: 2 samples (1 %) Der f 1: 5 samples (2 %)
Dong and Yao, 2010 (25) Beijing, China	Office, hospital,subway, train station	ELISA	Der p 1 and Der f 1 (range): (0.063 to 0.327) μg g^{-1}	None
Babe et al., 1995 (30) USA	Hospital	Microscopic counting 120 floor samples from carpeted and noncarpeted rooms and hallways	Number of mites, *D.pteronyssinus* and *D.farinae*: Range: (0 to 143) mites per gram; Mean: 28 mites per gram (carpeted rooms)	Only 1 sample from noncarpeted room
Wickens et al., 1997 (24) New Zealand	Hospitals	ELISA 19 floor samples 15 bed samples	Der p 1: Floor: IQR (0.04 to 0.51) μg g^{-1}; GM 0.14 μg g^{-1} Bed: IQR (0.02 to 0.47) μg g^{-1}; GM 0.10 μg g^{-1}	None
Solarz et al. 1998 (28) Poland	Hospitals	Microscopic counting 122 floor or bed samples	Number of mites (range): Floor: (1 to 100) mites per gram Bed: (2 to 100) mites per gram Proportion of pyroglyphid mites: 57.5 %	None
Ćustović et al. 1998 (29) UK	Hospitals	ELISA 83 carpet samples 69 bed samples 42 upholstered chairs	Der p 1	None
Eberlein et al. 2009 (27) Germany	Hospitals	ELISA 30 bed samples	Der p 1 (IQR): (0 to 0.2) μg g^{-1}; Der f 1 (IQR): (0.15 to 0.8) μg g^{-1}	
Wickens et al., 1997 (24) New Zealand	Hotels	ELISA 15 floor samples 15 bed samples	Der p 1: Floor: IQR (2.06 to 13.41) μg g^{-1}; GM 5.26 μg g^{-1} Bed: IQR (1.54 to 8.28) μg g^{-1}; GM 3.57 μg g^{-1}	Majority of samples

Table 1 *Continuation*

Study (reference number)	Sampling place	Method and number of samples	House dust mites number or allergen levels	Percent of samples above the sensitisation threshold*
Simplicio et al., 2007 (31) Brazil	Hotels	ELISA 42 carpet samples 98 bed samples	Der f 1: Floor: IQR (4.31 to 9.26) μg g^{-1}; GM 6.3 μg g^{-1} Bed: IQR (8.34 to 15.30) μg g^{-1}; GM 11.30 μg g^{-1} Der p 1: Bed: IQR (0.13 to 0.18) μg g^{-1}; GM 0.15 μg g^{-1}	Der f 1 in all samples Der f 1 levels > 10 μg g^{-1}: (58 to 76) % of samples
Solarz et al. 1998 (28) Poland	Libraries	Microscopic counting 14 chairs, desks, book-shelves or book samples	Number of mites (range): Chairs: (10 to 400) mites per gram Book-shelves and books: (250 to 400) mites per gram Desks: (1 to 14) mites per gram Proportion of pyroglyphid mites: 79 %	Majority of chair samples All samples from book-shelves and books
Abramson et al., 2006 (32) USA	School libraries (41 primary schools from 3 geographical regions)	ELISA 50 floor samples	Der p 1 (median): Southeast region: 2.5 μg g^{-1} Midwest region: 0.03 μg g^{-1} Southwest region: 7.5 μg g^{-1}	Majority of samples from southeast and southwest region
Ćustović et al. 1994 (33) UK	Cinemas	ELISA seat samples	Der p 1	30 % of samples Der p 1 levels > 10 μg g^{-1}: 9 % of samples
Wickens et al. 1997 (24) New Zealand	Cinemas	ELISA 13 floor samples 10 seat samples	Der p 1: Floor: IQR (0.54 per 2.26) μg g^{-1}; GM 1.11 μg g^{-1} Seat: IQR (2.58 to 14.51) μg g^{-1}; GM 6.12 μg g^{-1}	Majority of seat samples
Wickens et al. 1997 (24) New Zealand	Churches	ELISA 29 floor samples	Der p 1: IQR (0.71 to 3.34) μg g^{-1}; GM 1.54 μg g^{-1}	Minority of samples
Engelhart et al. 1999 (39) Germany	2 submarines A in harbour for 3 months B cruising for 3 months	ELISA 28 bunk mattress samples	Der p 1+Der f 1: A submarine: < 0.5 μg g^{-1} B submarine: median 4.4 μg g^{-1}	A submarine: none B submarine: 73 % of samples
Macan et al. 2005 (38) Croatia	Fishing boats	ELISA (Dustscreen™) 5 samples from cabin floor 5 samples from cabin beds	Der p 1: Floor: range (0 to 0.65) μg g^{-1}; median 0.05 μg g^{-1} Bed: range (0.1 to 15) μg g^{-1}; median 10 μg g^{-1}	Majority of bed samples
Colloff MJ 1986 (35) UK	Trains	Microscopic counting 16 upholstered seat samples 6 samples from stored blankets and pillows	Number of mites in 22 samples (range): (4 to 12) mites per gram Proportion of pyroglyphid mites: 55 %	None
Wickens et al. 1997 (24) New Zealand	Airplanes	ELISA 14 floor samples 14 seat samples	Der p 1: Floor: IQR (0.18 to 0.47) μg g^{-1}; GM 0.29 μg g^{-1} Seat: IQR (0.89 to 2.93) μg g^{-1}; GM 1.62 μg g^{-1}	Minority of seat samples
Uehara et al. 2000 (36) Japan	Trains	Modification of ELISA 10 μg of antigen = 100 mites 492 seat and bed cloth samples	Monoclonal antibody against *D. farinae* or *D.pteronyssinus*	Most samples >100 mites per square meter

Table 1 *Continuation*

Study (reference number)	Sampling place	Method and number of samples	House dust mites number or allergen levels	Percent of samples above the sensitisation threshold*
Partti-Pellinen et al., 2000 (34) Finland	Trains, buses, and trams	ELISA 18 floor and seat samples	Der p 1, Der m 1: < 0.05 μg g^{-1} Der f 1: not detectable	None
Pereira et al. 2004 (37) Brazil	Buses, taxies	ELISA 120 seat samples from buses 60 seat samples from taxies	Der p 1 and Der f 1	Der p 1: 82 % of bus samples Der f 1: 58 % of bus samples
Radon et al. 2000 (42) Germany	Pig-farms (100)	ELISA 500 samples: 300 confinement samples, 100 transit area sample, 100 farmer mattress sample	Der p 1: Confinement samples: range (0 to 3.3) μg g^{-1}; median 0 Transit area samples: range (0 to 10) μg g^{-1}; median 0.2 μg g^{-1} farmer mattress samples: range (0 to 774) μg g^{-1}; median 53.4 μg g^{-1}	None for confinement samples
Pennanen et al. 2003 (40) Finland	Laboratory animal facilities	Microscopic counting 20 samples from floor, animal cages, food, bedding, lounge chairs ELISA 4 samples	44 and 56 mites per gram (median) Only one pyroglyphid mite in a chair sample Der p 1: 0,002 μg g^{-1} in one of the 4 allergen samples	None
Solarz et al. 2004 (41) Poland	Zoo cages	Microscopic counting 49 cage samples (dust, litter, debris, residue)	*D.farinae*: < 1 % of total mite fauna	None
Rimac et al. 2010 (43) Croatia	Poultry farms	ELISA 17 floor and cage samples	Der p 1: range (<0,10 to 3.30) μg g^{-1}; median 0.78 μg g^{-1}	Minority of cage samples
Solarz et al. 2007 (44) Poland	Outdoor communal waste	Microscopic counting 86 samples of litter soiled with communal waste	No pyroglyphid mites found	None
Harju et al. 2006 (45) Finland	Groceries (storage and sales rooms)	Microscopic counting 56 samples from cashier's chair, floor and pet aisles, fruit/ vegetable section, bread counter) ELISA 14 samples from cashier's chair,floor aisle,storage area	One sample out of 14 contained detectable levels of Der p 1 [80 times smaller than the concentration suggested causing sensitization (2 μg g^{-1})] and none had detectable Der f 1 levels	None

** sensitisation threshold: >2 μg of mite allergen or >100 mites per gram of dust.*
IQR: interquartile range; GM: geometric mean; ND: not detectable; Der m 1: main allergen of D. microceras

contribute to the development of sensitisation and allergic disease, which can be categorised as work-related disease, that is, disease partially caused by workplace. In such cases, occupational physicians should be able to establish this relation. This should involve measurement of exposure at home and at work, and if a work-related disease is established, these workers should be entitled to benefits provided by local laws.

Table 2 *Workplaces and occupations at risk of clinically significant exposure to pyroglyphid mites in temperate climate regions.*

Workplace (reference number)	Occupation	Risk level
Hotels (24, 31)	hotel chambermaids	High
Cinemas (24, 33)	all staff	Moderate
Fishing-boats (38)	fishermen	Moderate
Submarines, ships (39)	all crew	Moderate
Libraries (28, 32)	librarians, cleaners	Moderate
Schools (46, 47)	teachers, cleaners	Low-moderate*
Day care centres (46)	day care workers	Low-moderate*
Offices (20, 21)	office workers, cleaners	Low
Churches (24)	priests	Low
Airplanes (24)	all crew	Low
Buses, trains, trams, taxies (34-37)	all crew	Low
Poultry farms (43)	poultry farm workers	Low

Risk levels: High: exposure mainly above the symptom threshold (>10 μg g^{-1} or >500 mites per gram of dust)
Moderate: exposure mainly between the sensitisation and the symptom threshold [(2 to 10) μg g^{-1} or (100 to 500) mites per gram of dust]
Low: occasional exposure above the sensitisation threshold (>2 μg g^{-1} or >100 mites per gram of dust)
** varies with dampness, ventilation, heating, and cleaning*

To prevent sensitisation or aggravation of allergic disease, occupational physicians should design pre-employment examinations and regular health surveillance to include occupational exposure to dust mites (52). Preventive action should also involve control of dust mite population at work through the use of fibreless furnishing, proper building maintenance, ventilation, heating, and regular cleaning (16, 46-48). These measures should be strictly implemented, particularly in hotel rooms, fishing boat cabins, or submarines with beds (24, 31, 38, 39).

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Sažetak

PIROGLIFIDNE GRINJE (*PYROGLYPHIDAE*) KAO IZVOR PROFESIONALNIH ALERGENA

Piroglifidne grinje smatraju se prvenstveno izvorom alergena u našim domovima. Postoji, međutim, sve više studija koje upućuju na izloženost piroglifidnim grinjama u javnim i radnim prostorima. Cilj je ovog pregleda prikazati alergene piroglifidnih grinja kao potencijalne štetnosti vezane uz radna mjesta i utvrditi rizična zanimanja za pojavu i progresiju bolesti uzrokovanih piroglifidnim grinjama. Iz baze PubMed izdvojene su studije koje su istraživale izloženost piroglifidnim grinjama (porodica *Pyroglyphidae*, rod *Dermatophagoides*) u različitim javnim i radnim prostorima. Piroglifidne grinje ili njihovi alergeni pronađeni su na različitim radnim mjestima, ali klinički značajne izloženosti zabilježene su u hotelima, kinima, školama, vrtićima, knjižnicama, vozilima (autobusima, vlakovima, taksi-vozilima), avionima, ribarskim brodovima, podmornicama, peradarnicima i crkvama. Predloženo je stupnjevanje rizika na radnim mjestima sa značajnom izloženosti alergenima piroglifidnih grinja kao niskog (povremena izloženost razinama >2 μg g^{-1}), umjerenog (izloženost pretežno između 2 μg g^{-1} i 10 μg g^{-1}) i visokog rizika (izloženost pretežno >10 μg g^{-1}). Pri procjeni razine rizika treba uvijek uzeti u obzir čimbenike koji značajno utječu na populaciju grinja (klimatska regija, karakteristike zgrade, način čišćenja). Specijalisti medicine rada trebali bi razmotriti moguću profesionalnu izloženost piroglifidnim grinjama pri procjeni opasnosti za radna mjesta i provedbi mjera zaštite na radu, pri profesionalnoj orijentaciji, prethodnim i periodskim pregledima te dijagnostici bolesti vezanih uz rad, u svrhu prevencije pojave ili pogoršanja alergijskih bolesti uzrokovanih piroglifidnim grinjama. Mjere zaštite na radu trebaju biti usmjerene kontroli populacije grinja na radnom mjestu, uključujući odgovarajuće uređenje interijera, te redovito čišćenje i održavanje zgrade.

KLJUČNE RIJEČI: *alergeni unutarnjih prostora, alergijske bolesti, bolesti vezane uz rad,* Dermatophagoides species*, Der p 1, Der f 1, profesionalna izloženost*

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