Polish Journal of Microbiology
2005, Vol. 54, Suppl., 13–20

Exposure to Moulds in Flats and the Prevalence of Allergic Diseases – Preliminary Study

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A b s t r a c t

The presented study concerned mycological analysis of buildings in Łódź and evaluation of the role between filamentous fungi contaminated flats and inhabitants health (allergic airway diseases). 49 inhabitants of 20 flats with signs of moulds contamination were examined. Air samples were collected in houses and outdoors. In all inhabitants skin prick tests (SPT) to common allergens and to standardized particular fungal extracts were performed. Moreover, total and serum specific IgE to moulds, rest spirometry were measured in all subjects. Level of moulds contamination in the air of flats was high and in 75% cases exceed accepted limits. The most frequent species isolated from examined rooms were: *Penicillium*, *Cladosporium*, *Aspergillus*, *Acremoniu* and *Alternaria*. The most frequent symptoms reported by examined subjects were rhinitis (N = 29, 59.2%), conjunctivitis (N = 29, 59.2%), chronic cough (N = 24, 49%), dyspnea (N = 15, 30.6%) and skin symptoms (N = 24, 49%). Elevated IgE level was found in 12 subjects (24.5%) and in three patients (6.1%) mould specific serum IgE were detected. Nineteen out of all subjects (38.8%) had positive SPT to common allergens (house dust mites, grass and tree pollens). Eight out of these patients (16.3% of the group) were sensitized to moulds (*Candida albicans*, *Alternaria alternata*, *Botrytis cinerea*, *Trichophyton mentagrophytes*, *Helminthosporium halodes*, *Aspergillus*). In all cases sensitisation to moulds was accompanied by allergy to other common allergens. No isolated hypersensitivity to moulds was found. Although the frequency of self-reported symptoms was high, the prevalence of atopy and allergic diseases seems to be similar to that found in general population, but that statement must be confirmed by comparison of the control group.

K e y w o r d s: allergy, moulds, mycological analysis of buildings

Introduction

While moulds commonly occur in the outdoor environment, they are also frequently found in the indoor environment of residential houses. Numerous researchers are interested in the effect of fungi growing in flats on the health of their residents. The above-mentioned effect needs to be discussed within the scope of both medical and biological sciences. Building biology should include, among others, building mycology, which deals with fungal species colonising built-up spaces.

Fungi may contribute to the deterioration of buildings, involving building, insulating and finishing materials. Wallpaper, surfaces covered with emulsion paint, wood and wooden products, carpets, PVC or insulating materials may provide a source of nutrients for fungi or maintain their growth, as they contain trace amounts of organic contamination.

Mould contamination of interiors is a common phenomenon across our continent, and it results from a particular ability of fungi to adapt to the living conditions affected by the climate, flooding, construction errors and thermal modernization of buildings. The scale of the phenomenon is enormous: it is estimated that 2.7 million (25%) Polish flats face the problem of mould contamination. The residents, whose number reaches 8 million, are exposed to mycotoxins and allergens produced by moulds inhabiting building and finishing materials (Zyska, 1999).

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Studies carried out in a number of countries demonstrate that the interior of a building and its outer hull may contain up to 434 fungal species (Flannigan *et al.*, 2001; Zyska, 2001). Mould contamination of flats is of particular interest because of its potentially harmful effect on human health (Flannigan *et al.*, 2001). Contaminated materials affect the quality of the indoor air and, thus, may produce negative consequences for the health of residents. Some fungi, including moulds, are capable of producing mycotoxins with carcinogenic, teratogenic and neurotoxic properties (Nielsen *et al.*, 1999; Flannigan *et al.*, 1991).

Apart from neoplastic diseases, airborne conidia and hyphae fragments may induce various health problems, such as diseases of the upper and lower respiratory airways, *i.e.* allergies or serious opportunistic infections among patients with impaired immune function. Moulds are a major group of inhalatory allergens beside animal allergens, pollens and dust mites (Eggleston and Bush, 2001). Depending on the environmental factors, the number of spores per air volume unit exceeds the number of pollens by 100 to 1000 times (Kwaśniewska, 2004). Small sizes of spores enable them a deep penetration of the bronchial tree, which may cause allergic reactions of both the upper and the lower respiratory tract. Mould exposure can result in allergic rhinitis (characterised by sneezing, rhinorrhoea and/or nasal congestion), allergic asthma, allergic sinus disease and hypersensitivity pneumonitis (Lipiec *et al.*, 2000; Kurnatowska, 1995; Flannigan and Miller, 1994).

The aim of this study was to evaluate the influence of living in buildings contaminated by moulds on inhabitants' health especially in the aspect of the prevalence of allergy.

Experimental

Materials and Methods

Flats. The study presented in the paper included mycological analysis of flats in the city of Łódź and the nearby area. Mycological analysis was carried out in 20 flats demonstrating clear signs of mould contamination. The flats were part of old tenant houses, blocks of flats or detached houses.

Identification of the number and type of moulds. Mycological analysis of flats included a qualitative and quantitative assessment of moulds present on the dividing walls and in the air. The analysis of swabs from the walls was performed by culture method; the air was aspirated with an Impactor Fb5 air sampler manufactured by Klotz. Fermentation medium with chloramphenicol was used for the isolation of moulds. The isolated fungi were classified by species on the basis of species identification keys (Fassiatová, 1983; Samson *et al.*, 1996; Flannigan *et al*., 2001).

Determination of ergosterol content in building materials and indoor air. Seitz *et al.* (1979) method was applied to determine the ergosterol content. Samples of building materials, about 1–3 g each, had their surfaces measured and were disintegrated into mortar, transferred into 100 ml of methanol and extracted in a shaker for 30 min. at 150 rpm. Ergosterol content in the air was determined on a gelatine filter (Sartorius) after the filtration of 1000 l of the air with Sampler FB5 (Klotz). Filters were transferred into methanol and extracted (in the same way as the building materials). Methanolic solutions was decanted into a 300 ml flask and then 5 ml of 1 M of methanolic KOH solution was added and heated under a reflux condenser for 30 min. After cooling the solution to about 4°C, the sample was extracted twice with 50 ml of hexane for 2 min. The separated upper hexane fraction containing sterols was evaporated dry in a vacuum evaporator. The residue was dissolved in 30 ml of methanol and analysed spectrophotometrically. For the obtained methanol solution the absorbance was measured at $\lambda = 282.6$ nm using Beckman DU 640 spectrophotometer. The ergosterol content was read from the calibration curve. The resulting ergosterol content was expressed in μg of ergosterol per 100 cm^2 of the building material sample surface or in μg of ergosterol per 1000 l of the air.

Subjects. The study group considered for final analysis comprised 49 inhabitants (aged 3–85 years) of 20 flats with signs of moulds contamination from Łódź. None of the subject reported taking antihistamine or antiasthmatic medications at the time of examination. The Regional Bioethical Committee approved the study protocol. All the participants gave their informed consent prior to the study.

Questionnaire. On the day of medical examinations, the subjects were administered a questionnaire that was an adaptation of the instrument developed by the International Union against Tuberculosis and Lung Disease (IUATLD) (Burney *et al.*, 1989). All the participants were interviewed and examined by a physician. The questionnaire included a history of physician-diagnosed allergic diseases, personal and family history of atopy; tobacco smoking status; exposure to pet allergens at home and housing conditions (new or old building). The symptoms suggestive of asthma included wheezing, chest tightness, and shortness of breath or cough under normal conditions or induced by exercise, exposure to cold air, smoke, dust or strong odours. The smoking status was denominated by three categories: current smokers, ex-smokers and non-smokers.

Skin prick tests. Skin prick tests (SPT) were performed on the volar part of the forearm with a standard battery of common allergens: including tree and grass pollens, *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae* and mould series: *Alternaria tenuis*, *Aspergillus fumigatus*, *Botritis cinerea*, *Candida albicans*, *Trichophyton mentagrophytes*, *Cladosporium herbarum*, *Penicillium notatum*, *Pullularia pullulans*, *Alternaria*, *Aspergillus mix.*, *Cladosporium*, *Penicillium mix*, (Allergopharma, Germany). Negative control was allergen diluent and the positive one – 1 mg/ml histamine dihydrochloride solution. The largest wheal diameter was assessed after 15 min. Positive reaction was defined as a wheal diameter of at least 3 mm with no reaction to the diluent and a positive reaction to histamine.

Total and specific IgE. Total serum IgE was evaluated with the use of the Uni-CAP system (Uppsala, Pharmacia Diagnostics, Sweden). Total IgE level > 100 KU/L was regarded as elevated. The presence of moulds specific IgE antibodies was demonstrated

using allergen CAPS (Phadezym mx2 (*Penicillium notatum*, *Cladosporium herbarum*, *Aspergillus fumigatus*, *Candida albicans*, *Alternaria alternata*, *Helminthosporium halodes*), Pharmacia, Diagnostics, Uppsala, Sweden). Additionally, in subjects with positive mx2 results testing with CAP RAST such as: *Penicillium notatum* (m1), *Aspergillus fumigatus* (m3), *Candida albicans* (m5), *Alternaria alternata* (m6) was performed. The results were expressed quantitatively in kilounits per litre, considered positive at values higher than 0.35 KU/L and also presented in classes (Yman *et al.*, 2001).

Pulmonary function. Resting spirometry (Vicatest 2A, Mijnhardt, the Netherlands) was performed in all subjects.

Statistical analysis. The data were analysed using the Statistics 4.5 for Windows. The prevalence, *i.e.* the proportion of subjects reporting analysed signs and symptoms or presenting changes in laboratory tests was calculated.

Results

Mycological analysis of flats. Results of mycological analysis of flats are presented in Table I. A large number of moulds on the walls of the attacked flats (4.33×10^7 CFU/100 cm^2) indicates active fungal growth and numerous spores contaminating the indoor air. The number of moulds in the air, 4.02×10^3 jtk/m^3, means a high level of mould contamination and a risk of its negative impact on living organisms. The assessment of mould contamination according to literature criteria (Krzysztofik, 1992) revealed that in the majority of flats, 75% (15 flats), the air was highly contaminated, 20% had a medium level of contamination, while only in one flat affected by fungi the air was contamination-free. A control test of the outdoor air outside the affected flats showed a low level of contamination, lower than that of the indoor air, which points to the occurrence of internal sources of fungi. The minimum number of moulds in the outdoor

Table I
Results of the mycological analysis of flats (N = 20)

Mould count on the dividing walls – mean, minimum and maximum value [CFU/100 cm^2]	4.33×10^7, 1.33×10^3, 4.60×10^8
Mould count in the air – mean, minimum and maximum value [CFU/1000 m^3]	4.02×10^3, 9.50×10, 2.50×10^4
Ergosterol content of the dividing walls – mean, minimum and maximum value [µg/100 cm^2]	11.7, 1.8 20.4
Ergosterol content of the indoor air – mean, minimum and maximum value [µg/1000 m^3]	2.7, 1.4 6.4
Fungal species isolated from the walls – their percentage share in the total pool of fungi	***Penicillium* sp. 33%** (*P. expansum* 15%, *P. brevicompactum* 9%, *P. chrysogenum* 3%, *P. diversum* 3%, *P. italicum* 3%) ***Cladosporium* sp. 24%** (*C. cladosporoides* 18%, *C. herbarum* 6%) ***Aspergillus* sp. 21%** (*A. versicolor* 12%, *A. niger* 6%, *A. ochraceus* 3%) ***Alternaria alternata* 9%** ***Acremonium strictum* 9%** ***Ulocladium chartarum* 3%** ***Stachybotrys atra* i inne 1%**
Fungal species isolated from the air – their percentage share in the total pool of fungi	***Penicillium* sp. 45%** (*P. chrysogenum* 20%, *P. expansum* 4%, *P. notatum* 4%, *P. viridicatum* 4%, *P. diversum* 2%, *P. granulatum* 2%, *P. brevicompactum* 2%, *P. terrestre* 3%, *P. italicum* 1%, *P. citrinum* 1%, *P. ehinulatum* 2%) ***Cladosporium* sp. 22%** (*C. cladosporoides* 8%, *C. herbarum* 8%, *C. spherospermum* 6%) ***Aspergillus* sp. 17%** (*A. niger* 9%, *A. versicolor* 6%, *A. flavus* 2%) ***Alternaria alternata* 5%** ***Acremonium strictum* 5%** ***Rhizopus nigricans* 1%** ***Trichoderma viride* 1%** ***Mucor racemosus* 1%** ***Aureobasidium pullulans* 1%** ***Ulocladium chartarum* 1%** ***Scopulariopsis brevicaulis* 1%**

air outside the buildings was 8×10^1 CFU/m^3, while the maximum amounted to 2.2×10^3 CFU/m^3. The estimation of the dividing walls for their ergosterol content according to literature criteria (Gutarowska and Żakowska, 2000) demonstrated that only 10% of flats had an acceptable level of contamination (less than 2 µg/100 cm^2). The other flats (90%) showed a high level of ergosterol, exceeding 4 µg/100cm^2, in most cases reaching 10–12 µg/100 cm^2. The level of ergosterol, a component of fungal cells, is a sign of high fungal growth activity and of long-lasting processes of moulding.

The fungi isolated from the affected flats, representing mainly the genera of *Penicillium* sp. (45% of all airborne fungi), *Cladosporium* sp. (22%), *Aspergillus* sp. (17%), *Alternaria* sp., *Acremonium* sp., are common human aeroallergens. Most of the species occurred both on the walls and in the indoor air. A frequent occurrence of *Cladosporium cladosporoides* and *Alternaria alternata* should be noted for their well-known allergenic properties. Also the occurrence of the toxin-producing *Aspergillus versicolor*, both on the walls and in the air (with the frequency of 12% and 6%, respectively) should be emphasised.

Analysis of inhabitants' health. The baseline characteristics of the study group are summarized in Table II. The mean age of the subjects was 37.8 ± 19.6 years. Ten (20.4%) children and 39 (79.6%) adults (over 18 years old) were examined. The group consisted of 21 males and 28 females.

Symptoms of possible allergic origin reported by examined subjects are presented in Table III. The incidence of self-reported symptoms was high. Rhinitis and conjunctivitis were the most frequently reported symptoms – by 59.2% of subjects. 49% of subjects reported cough and 30.6% dyspnoea. Moreover, 14 out of 29 subjects (48.3%) with rhinitis and 44.8% with conjunctivitis experienced improvement symptoms when leaving a flat. The results of resting spirometry remained within normal range in all subjects.

Table II
Characteristics of study group – results of questionnaire survey

	Examined group N = 49		Examined group N = 49
Age [years] (mean ± SD)	37.8 ± 19.6	Smoking: active smokers	9 (18.4%)
Gender, M : F	21 (42.9%) : 28 (57.1%)	ex-smokers	11 (22.4%)
Pets at home	23 (46.9%)	passive smokers	17 (34.7%)

M – males; F – females

Table III
Symptoms of possible allergic origin reported by examined subjects (N = 49)

Symptoms	Number and proportion of subjects reporting symptoms N = 49
Cough	24 (49%)
Expectoration	13 (26.5%)
Dyspnoea	15 (30.6%)
Rhinitis symptoms	N = 49
Rhinitis, sneezing	29 (59.2%)
	N=29
blockage of the nose longer than a month per year	29 (100%)
improvement of symptoms when subject was outdoor	14 (48.3%)
perennial symptoms	13 (44.8%)
seasonal symptoms	16 (55.2%)
Conjunctivitis symptoms	N = 49
Conjunctivitis	29 (59.2%)
	N = 29
improvement of symptoms when subject was outdoor	13 (44.8%)
perennial symptoms	18 (62.1%)
seasonal symptoms	9 (31%)
Skin symptoms	N = 49
Oedema	11 (22.4%)
itching	24 (49%)

Table IV
Results of skin prick tests to common allergens in examined group (N = 49)

Allergen	Number and proportion of positive results (N = 49)	Allergen	Number and proportion of positive results (N = 49)
Common allergens	19 (38.8%)	Mould allergens	8 (16.3%)
Dermatophagoides farinae	10 (20.4%)	*Alternaria tenuis*	4 (8.2%)
Dermatophagoides pt.	8 (16.3%)	*Aspergillus fumigatus*	1 (2%)
Grass pollens	7 (14.3%)	*Botrytis cinerea*	1 (2%)
Trees pollens I[1]	4 (8.2%)	*Candida albicans*	2 (4.1%)
Trees pollens II[2]	7 (14.3%)	*Trichophyton mentagrophytes*	1 (2%)
Weeds	4 (8.2%)	*Alternaria sp.*	3 (6.1%)
Feathers	1 (2%)	*Aspergillus mix.*	1 (2%)
Moulds I[3]	4 (8.2%)	*Penicillium mix.*	1 (2%)
Moulds II[4]	1 (2%)		

[1] alder, hazel, poplar, elm, willow
[2] bird, beech, oak, plane
[3] *Alternaria tenuis, Botrytis cinerea, Cladosporium herbarum, Culvularia lunata, Helminthosporium, Fusarium moniliforme*
[4] *Aspergillus fumigatus, Mucor mucedo, Penicillium notatum, Pullularia pullulans, Rhizopus nigricans, Serpula lacrimans*

Table V
The results of total and specific to moulds IgE

Test	Number and proportion of positive results (N = 49)
IgE >100 KU/L [N (% group)]	12 (24.5%)
mx2 [N (% group)]	3 (6.1%)
m1 (*Penicillium notatum*) [N (% group)]	1 (2.7%)
m3 (*Aspergillus fumigatus*) [N (% group)]	1 (2.7%)
m5 (*Candida albicans*) [N (% group)]	1 (2.7%)
m6 (*Alternaria alternata*) [N (% group)]	3 (6.1%)

Results of skin prick tests to common allergens in examined group and total and specific to moulds IgE are presented in Tables IV and V. The prevalence of skin hyperreactivity to separate allergens tested is presented in table IV. Generally, 19 patients (38.8%) displayed positive SPT to common allergens. The most frequent allergens yielding positive results were *Dermatophagoides farinae* (20.4%), *Dermatophagoides pteronyssinus* (16.3%), and grass and trees pollens (14.3%). Eight subjects had positive SPT to moulds. In 4 cases sensitisation to *Alternaria tenuis* was found. In all of patients allergic to moulds sensitisation to other common allergens was found. The total IgE level was elevated in 12 subjects (24.5%). 6.1% of the examined subjects displayed the presence of mould-specific IgE. *Alternaria alternata* specific IgE was found in 3 subjects.

Discussion

Allergologists distinguish between outdoor and indoor moulds. It has to be born in mind, however, that some species can occur in both environments, which is confirmed by the results of numerous studies as well as literature. Presence of the some species in outdoor and indoor environment is especially visibility during the summer (Flannigan *et al.*, 1991).

In the present study, *Penicillium, Cladosporium*, *Aspergillus* were detected as most commonly occurring genera. The results are similar to those obtained in other countries, such as UK and Canada, which is related to their moderate climate (Miller, 1988; Hunter *et al.*, 1988; Flannigan, 1991). *Penicillium* was detected most frequently: in English flats, it was isolated with the frequency of 99%, in Canadian flats – 80%, and 99% for this study. Taking into account the frequency of occurrence of individual genera in indoor

environments of countries with the same climate, one may suggest *Penicillium*, *Cladosporium* and *Aspergillus* as indicators of indoor air contamination, just as the concentration of *Alternaria* and *Cladosporium* spores indicates the contamination of the outdoor air.

In one of the flats covered by the study, the dangerous species of *Stachybotrys atra* was detected. Numerous authors claim that its presence in residential buildings is inadmissible because of a significant health risk resulting from its toxin-producing abilities (Miller, 1988; Flannigan, 2001; Johannig *et al.*, 1996). It is worth noting that the species was isolated from wallpaper, similarly to the studies of other authors.

The level of contamination in Polish flats does not significantly differ from that in other countries (Hunter *et al.*, 1988; Miller, 1988). On average, 4×10^3 CFU of moulds /m^3 were detected in the indoor air of the affected flats (in other countries: 2.5×10^3 CFU /m^3 – 4×10^3 CFU /m^3). However, a high level of ergosterol was observed in the flats covered by this study: 1.4–6.4 mg per 1 m^3 of indoor air (average of 2.7 mg/1 m^3), while other authors (Miller, 1988) quote the levels of 0.8–3.2 mg/1 m^3. High ergosterol levels accompanied by lower numbers of colony forming units detected by the culture method may be evidence of large numbers of dead spores and hyphae in the studied environment (Gutarowska, Żakowska, 2002). Such a situation may be a result of disinfection or long-term biodeterioration processes in the buildings, which seems true in this case, as the inhabitants estimated that their flats had been contaminated for 5–10 years (data based on questionnaires). The authors believe that the ergosterol assay is a reliable method of determining total fungal biomass in the air, reflecting the risk of exposure to both live, active fungi and dead ones, which may still maintain their allergenic properties. Literature confirms that the latter increase with the age of a fungal culture (Cole, 1991).

The most common indoor allergens that should be avoided include house dust mite, animals, cockroaches, and fungi (Eggleston and Bush, 2001). The effect of indoor mould on health is controversial. Some authors pointed out that mould exposure can result in allergic rhinitis, allergic asthma, allergic sinus disease or hypersensitivity pneumonitis. Moisture problems and mould growth in the buildings may cause a respiratory symptoms of the inhabitants, particularly wheezing and cough (Verhoeff and Burge, 1997; Peat *et al.*, 1998; Billings and Howard, 1998). On the other hand there has been no established dose-response relationship between mould levels and occurrence of health problems.

Kilpelainen *et al.* (2001) found the significant positive association between home dampness and current asthma, allergic rhinitis, but not with allergic conjunctivitis. Current atopic dermatitis was independently associated with home dampness. They also found a strong positive association between the number of common colds (≥4 during last year) and home dampness (excess of 29–48%). They found association between reported respiratory infections such as pneumonia, bronchitis, sinusitis, otitis media and home dampness in the homes with visible mould or damp stains (Kilpelainen *et al.*, 2001).

In our study the number of self-reported complains was high, *e.g.* cough (49%), dyspnoea (31%), rhinitis (59%) conjunctivitis (59%). However, it must be interpreted very carefully. The participants entered the study as volunteers. Some of the subjects were claiming for compensation or a new flat, which may explain the high prevalence of reported symptoms. We did not manage to examine all member of family at the flats, because usually only people who were worried about their health or having some symptoms that needed to be verified agreed to be examined. This might have resulted in over reporting some symptoms and the relatively high frequency of positive results of allergological tests. The participation rate was low. Only in 60% flats we examined all members.

Also Kilpelainen *et al.* (2001) point out that ill people and their physicians seek an explanation for symptoms which might lead to overestimation of the association between dampness, mould and disease. Additionally fungi may produce a variety of volatile organic compound and mycotoxins, it is suggested that this substances might lead by irritative mechanisms to nonallergic respiratory symptoms (Verhoef *et al.*, 1997; Rylander, 1997). For example cough was reported by almost 50% inhabitants. We had only 2 subjects with bronchial asthma but not due to moulds.

The prevalence of atopy, defined as skin hypersensitivity to at least one common aeroallergen, ranges from about 20% to over 60% of general population (Raport GINA, 2002). Thus, the frequency of positive SPT found in our study (38.8%) remains within the range for general population.

We did not found any isolated sensitisation to moulds. In all cases it was accompanied by with allergy to another common allergen, mainly *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, but also tree and grass pollens. Similar reports have indicated the same regularity (Bogacka, 1999).

Positive SPT to *Alternaria* occurred in 3.6% of the examined US population (17,000 subjects), and up to 70% patients with fungal allergy have skin test reactivity to *Alternaria*, over 80% of subjects with confirmed asthma have demonstrated positive reactions to 1 or more fungi (Gergen *et al.*, 1987; Lopez and

Salvaggio, 1985). *Alternaria* is a well-documented etiological agent of bronchial asthma and – according to American reports – also a risk factor of fatalities in the course of asthma (Halonen *et al.*, 1997; O'Hollaren *et al.*, 1991).

Similarly, Zock *et al.* (2002) in cross-sectional community study found positive skin prick test response to *A. alternata* and *C. herbarum* respectively in 4.7% and 2.4% subjects, and in 3.8% specific IgE to *C. herbarum* in over 15,000 group adult with asthma.

Surprisingly, the frequency of skin sensitisation to *A. alternata* in our study was 8.2%, which represents almost twofold increase in comparison to other studies. But again it may be the result of selection bias when enrolling patients into the study.

We found two subjects sensitized to *Candida albicans* and one to *Trichophyton mentagrophytes*. The yeast *Candida albicans* is ubiquitous commensal organism of human oral and vaginal mucosa and gastrointestinal tract as part of the normal flora. This species are not normally found growing indoor. It is possible that this sensitizations was the result of the presence of this fungi in human organism or previous/present infections.

The association between exposure to airborne fungi and the development of IgG antibodies has been documented only in occupational studies (Erkinjuntti-Pekkanen *et al.*, 1999). In contrast, to school-children from moisture problem schools this association was not found (Taskinen *et al.*, 2002). Fungal allergens have been shown to induce IgE-mediated hypersensitivity. But to our knowledge, it is not well known whether mould exposure in homes can affect development of IgE antibodies, especially that exposure to mould is wide in outdoor environment. In our study we mainly found IgE to *A. alternata* (6,1%) as principal outdoor allergen.

The most interesting finding of the result is relatively low frequency of specific sensitisation in inhabitants of flats contaminated by moulds. Moreover, assuming that people suffering from respiratory symptoms may have been more willing to participate in the study that the healthy ones, it can be even lower than it was found. Certainly further comparisons with well-matched control group are needed.

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