

Reduction of indoor airborne mould spores

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In 23 dwellings in Copenhagen high concentrations of airborne mould spores were shown by the "open Petri dish" method. The families were instructed how to reduce this contamination. One year later the number of mould spores was estimated again. At that time their number was 1/10 of that shown at the first sampling in 11 dwellings, and in 7 dwellings the reduction of mould spores decreased to 1/5. Only one dwelling showed no reduction.

Clinical aspects

Avoidance of exposure to allergens is extremely important in the treatment of allergic diseases. In this study we have evaluated whether it is possible by means of simple measures to reduce high concentrations of moulds in the homes of children with asthma.

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For more than 60 years moulds have been considered an important cause of asthma (2, 6, 7, 8, 9), and in western Europe 5–30% of patients with asthma have a positive skin test to microfungus extracts (4, 6, 8, 10).

In addition to outdoor airborne moulds, mould spores liberated from indoor growth foci can be suspected as aeroallergens. The local microclimate, especially the humidity, influences fungal growth. The relative humidity has an indirect influence on growth, which is dependent on available water on surfaces, e.g. condensation or water leakage.

In Denmark the humid climate makes indoor mould an important source of aero-allergens. Mould growth is further encouraged as new buildings are constructed with better insulation and less ventilation than older ones.

A main principle in the treatment of asthma is avoidance of exposure to allergens. This also applies for airborne mould spores. If the amount of airborne mould spores in a dwelling exceeds "normal colony counts" measures should be taken to reduce this pollution. The purpose of this observational study was to evaluate if such measures can reduce the indoor occurrence of moulds.

Material and methods

A 2-year study was carried out at the Pediatric Department, University Hospital, Gentofte, Denmark. Our routine examination of children with asthma includes questions about symptoms of mould allergy and questions concerning the occurrence of mould contamination in the patients' homes. Skin prick

tests and RAST with mould extracts are performed (1). If a patient's home is suspected of being contaminated with mould or the patient of being allergic to mould we investigate the indoor and outdoor occurrence of mould spores. This is done by gravity sampling using an open Petri dish (OPD) (3). The results are interpreted according to the Danish reference values for the occurrence of airborne mould spores in Danish homes (Fig. 1) (5). A dwelling came under study when the amount of airborne mould spores was high compared to the Danish reference for that month; the OPD technique was used.

When a home had been admitted to the study a specially trained person examined the home to find growth foci of moulds in order to correct construction faults or living habits.

One year later a second sampling was performed in the same month and under conditions identical to those of the first sampling.

Sampling procedure

Nine-cm Petri dishes containing V-8 agar as culture medium were used. V-8 is a vegetable juice with penicillin and streptomycin added to eliminate bacteria growth (3). Four sterile agar-plates were sent to the patient with instructions to expose each plate for 20 min. The sampling was done under usual living conditions. One dish was used for an outdoor sampling. Indoors, one dish was centrally exposed in each of three rooms. Usually, the child's room, the living-room and the bathroom or kitchen were chosen. Immediately after exposure the dishes were resealed and mailed to the laboratory (ALK Labo-

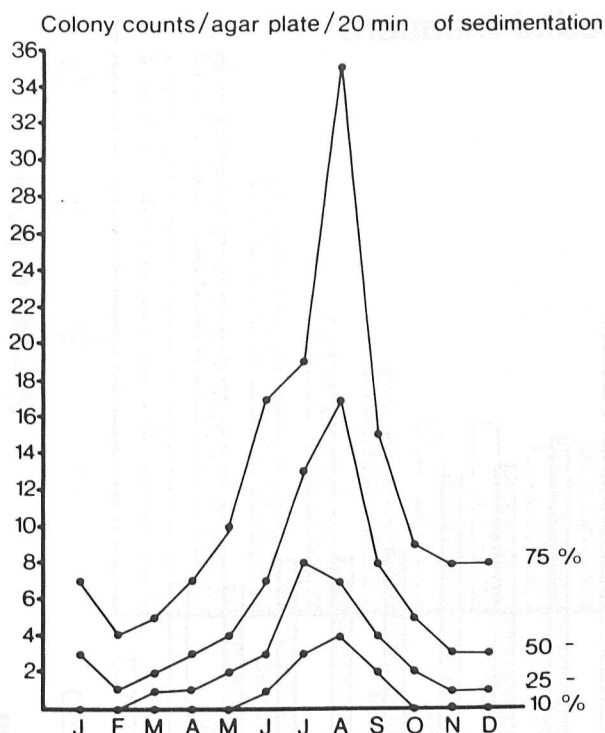


Fig. 1. Ten years' investigation of the airborne mould flora studied by 20-min exposure of open culture plates in Danish private homes (5325 rooms). Cumulative frequencies of colony counts have been calculated and the 25%, 50% and 75% percentiles are depicted. The seasonal variation of mould colonies is reproducible. The "normal colony count" was determined, based on the 50% percentile, to estimate the fungal contamination, regardless of season, that should serve as a guideline for the clinician in renovation and other spore-reducing procedures for the patients (5).

ratories, Hørsholm, Denmark). After 1 week of incubation at 25°C the mould colonies were counted and the genus identified and, if possible the species, by their macroscopical and microscopical characteristics (4).

Results

The total amounts of airborne mould spores in the three rooms at the first and second samplings are given in colony-forming units (cfu/plate/20 min) (Fig. 2). At the second sampling the number of mould spores had decreased in all but one dwelling. In 11 dwellings the number was reduced to 1/10, and in 7 dwellings to 1/5 compared with the first sampling.

Penicillium and *Cladosporium* were the genera most often encountered. In 13/23 homes a single dominant fungal genus could be identified and in 6/23 homes two fungi genera were present on the dishes with > 10 cfu/dish. In each dish 2–8 different genera were shown, usually 3–4. Fig. 2 shows the occurrence of genera in the 23 homes. Table 1 shows the indications for spore sampling.

Table 1. Indications for spore sampling in 23 dwellings

	No. of homes
Musty odour and/or visible growth of mould	13
Water damage to the building	2
Many plants in the building	3
A positive skin test to moulds	4
A characteristic seasonal pattern of symptoms	1

To compare the indoor and outdoor microflora an indoor and outdoor sampling was performed simultaneously. Only twice did the same genera dominate in both indoor and outdoor dishes.

Besides general steps (Table 2) individual measures were taken to reduce the mould contamination in the homes. In 5 cases bathroom ventilation needed to be improved. In 7 homes there was some kind of defect in the building insulation, while 2 new dwellings had insufficient air circulation.

Discussion

In 22 of 23 homes the number of cultured mould fungi was reduced at the second sampling. As any selection procedure based on a single abnormally high value will tend to result in a reduction on repeated measurements, the validity of our findings might be questioned. However, the trend of reduction in spore counts was marked. At the second sampling only one sample showed no reduction in spore numbers. In this home the offending source of contamination – a bathroom with insufficient ventilation and with visible mould spots on the walls – had not been eliminated.

Judged from our results it seems reasonable to assume that it is possible to obtain a considerable reduction of indoor airborne mould spores by simple measures. As this step was only one of many in the patient treatment, it has not been possible to evaluate the impact of this reduction of aeroallergens on the patient's clinical condition. This would require a controlled study.

In 19 of 23 cases with increased indoor airborne mould spores a suspicion of contamination arose by asking simple questions. Only four dwellings were

Table 2. General measures taken to abolish contamination with indoor mould (recommendation by the Danish Research Building Institute)

Increased airing (30 min at least twice a day)
No unheated rooms during winter
No indoor clothes drying
Repair insulation defects
Increased cleaning
Increased bathroom ventilation
Fewer indoor plants

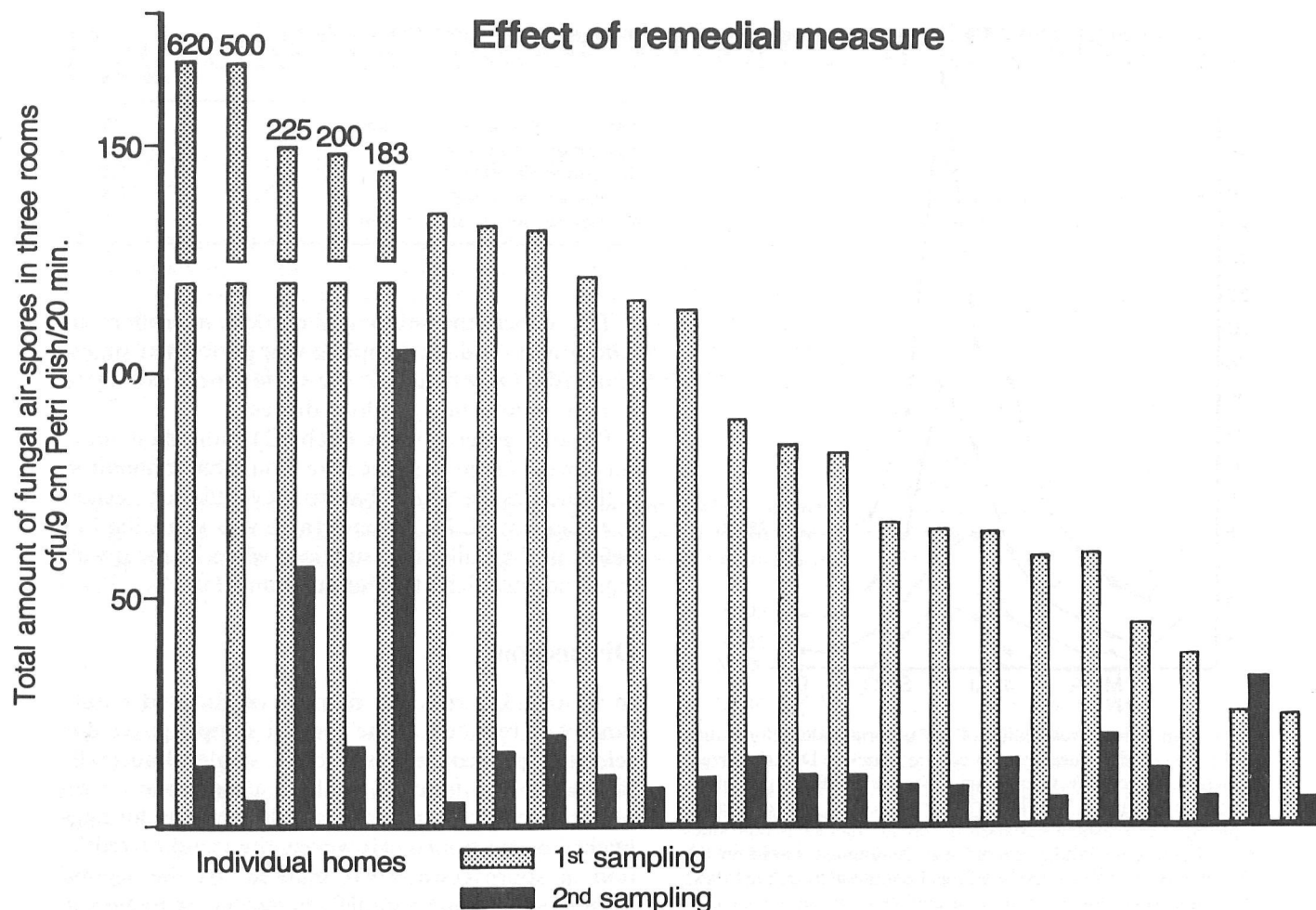


Fig. 2. Total amount of colony-forming units (cfu) in 3 rooms estimated by open Petri dish (OPD) method.

□: first sampling
■: second sampling

investigated because of a positive skin test. This emphasizes the importance of taking a detailed history from the patients and their families.

For practical reasons we have used OPD. This way of sampling relies on the gravitational deposition of mould spores. An advantage of this method is that after simple instructions, sampling can be carried out by untrained persons. A drawback to OPD is the strong influence of wind and air turbulence, which means that larger spores might be over-represented. However, in a comparative study the results obtained with OPD showed good correlation with those obtained with a "Slitsampler" and a "N6 - Andersen sampler" which both collect air into media at 30 l/min (10).

The quality of the results in the present study would have been significantly improved if a control group had been included. For ethical reasons this was not done. Besides, the variations in airborne

mould spores in Danish homes have been thoroughly studied by Gravesen (3). In that study the indoor microflora was detected monthly for 1 year in 3 rooms in each of 44 homes by means of OPD. Thus the results of OPD would appear useful as a semi-quantitative measure of the presence of moulds in the environment.

In only 2 cases did the genera of fungi peak simultaneously in the outdoor and indoor dishes. In fact, 21 indoor mould peaks were independent of the outdoor fungi. These observations suggest that control of patient's indoor environment could significantly reduce the exposure to mould spores.

The aim of the present study was to show whether the advice given to reduce indoor microflora does have the desired effect on the number of indoor airborne mould spores. In a following study the clinical consequences of a reduction in indoor airborne mould spores will be estimated.

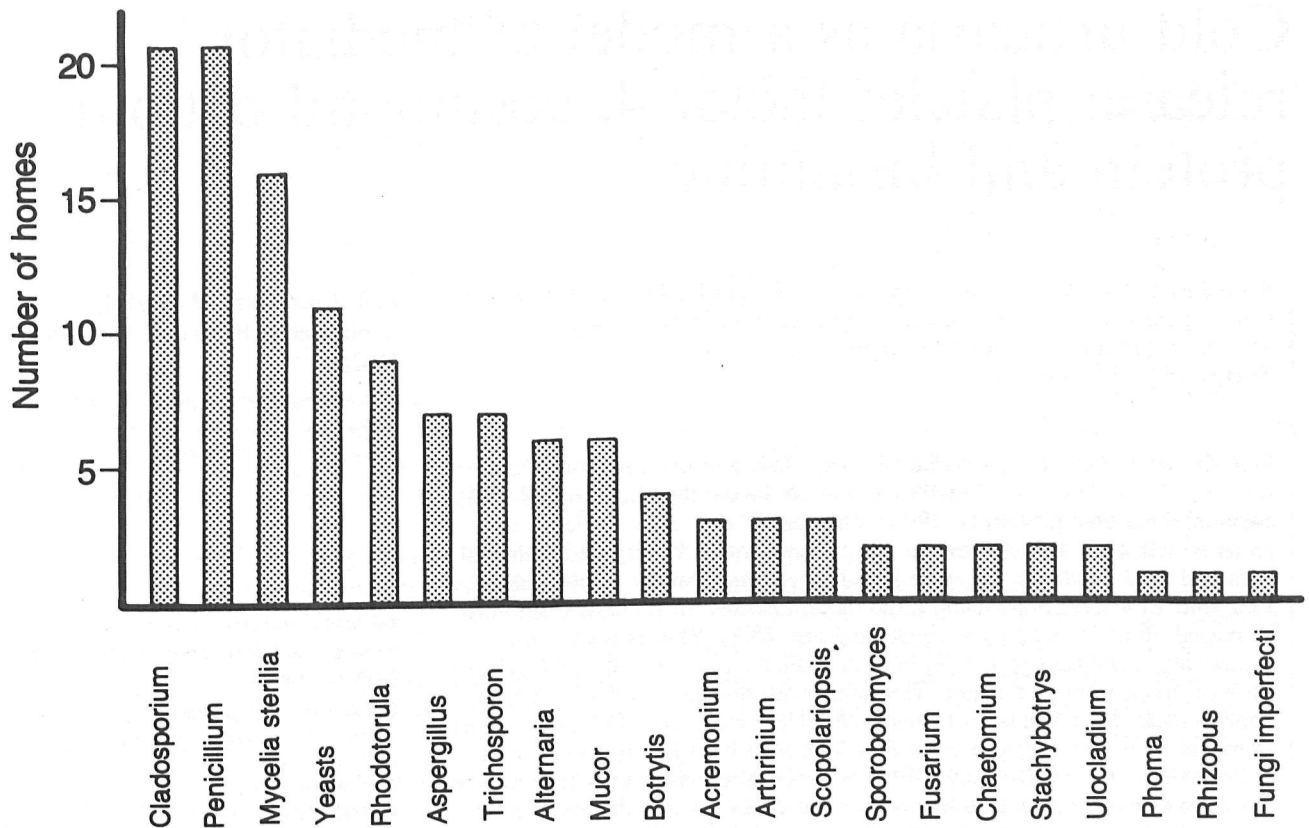


Fig. 3. Occurrence of fungal aerospores in 23 homes.

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