

Chip pile workers and mould exposure

A preliminary clinical and hygienic survey

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Chip pile workers are exposed to high concentrations of airborne mould spores. Few sporadic cases of allergic alveolitis have been reported in Finland. Eight non-smoking workers, six on chip piles and two on bark piles, were examined to study the immunological and clinical response to continuous mould spore exposure. The spore exposure ranged between 10^4 and 10^5 spores/m³. Three of the six chip pile workers had precipitating serum antibodies against *Aspergillus fumigatus*. The three antibody-positive workers had a tendency to decreased total pulmonary diffusion capacity and vital capacity. Significant respiratory symptoms were not noted. Long-term spore exposure may include an occupational health risk to chip pile workers.

Key words: mould spore exposure; precipitating antibodies; pulp mills.

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Storing of wood chips in large piles in pulp mills for many weeks forms suitable conditions for microbial growth. The temperature in a chip pile can reach 70°C and thus favours the growth of allergenic thermotolerant and thermophilic fungi. While unloading the piles and supervising and cleaning the conveyors, the workers can be exposed to airborne spores of moulds and yeasts. Exposure to fungal spores can cause a pulmonary hypersensitivity reaction: extrinsic allergic alveolitis (7). Sporadic cases of allergic alveolitis caused by mouldy wood dust have been reported in the trimming departments of sawmills and in the chipping department of a pulp mill (4, 10, 11). Also chip pile workers may have a risk of allergic reactions. In this study exposure and immunological as well as functional responses were examined in a small group of chip pile workers.

MATERIAL AND METHODS

To study the possible health risk caused by mould spore exposure at chip piles we collected

all non-smoking chip and bark pile workers in two pulp mills in eastern Finland (Enso-Gutzeit Oy). The group consisted of eight workers (1 female). The characteristics of the subjects are presented in Table 1.

The subjects were interviewed about any symptoms related to work, and examined physically. Chest X-ray was taken of each subject. Precipitating antibodies against *Aspergillus fumigatus*, *Aspergillus umbrosus*, *Thermoactinomyces vulgaris* and *Microspolyspora faeni* were measured using Wadsworth's modification of double diffusion in gel (Sero-Bacteriological Institute, University of Helsinki).

Total IgE was measured by PRIST®, and relevant specific antibodies against *Cladosporium herbarum*, *Aspergillus fumigatus*, *Alternaria alternata* and *Penicillium notatum* by RAST®. The same antibodies were also measured from eight non-exposed age- and sex-matched hospitalized control subjects. The serum and nasal eosinophils were counted. Skin prick tests were made with 16 common allergens and 12 different moulds.

The ventilatory volumes were measured by

flow-volume spirometry (Medikro 101, modified) and the total lung diffusion capacity by a single-breath carbon monoxide method (Morgan Resparameter Mark IV). A histamine inhalation challenge test for bronchial hyper-reactivity was performed with 1.6% histamine diphosphate employing DeVilbiss nebulizer No. 40 (5). Lung functions obtained were compared to national reference values (9).

The sampling of yeasts and mould spores on the chip piles was carried out by using the Andersen sampler. The colony-forming units of mesophilic and thermotolerant moulds (8) and thermophilic (3) and mesophilic actinomycetes (2) were calculated and identified on the culture plates after incubation (Institute of Occupational Health, Kuopio, Finland). The results were expressed as colony-forming unit per cubic meter of air sample (cfu/m³).

RESULTS

The subjects did not complain of any significant respiratory symptoms related to work. One subject had mild bronchiectasis which caused some cough and mucus flow. One patient had perennial rhinitis, which was diagnosed as vaso-

motoric. The chest X-rays were normal except in the subject with bronchiectasis. He and two others had precipitating antibodies against *Aspergillus fumigatus*. In the eight control subjects no serum antibodies were found. According to skin prick testing one subject was atopic. All the mould skin and RAST tests were negative. Total IgE was somewhat increased in one subject (185 U/l). Serum and nasal eosinophils were not increased. None of the subjects had increased bronchial hyperreactivity. In one subject lung diffusion capacity was 74% of the predicted. Ventilatory function was in the normal range in other subjects. However, there was a tendency toward a mild restriction and gas transfer disturbance in the three antibody-positive subjects (Table 1).

Work environment

The total number of spores/m³ on the chip piles differed according to the consistency and age of the piles (Table 2).

The total number of spores found in the bulldozer cabin while working on the 2.5 month old birch chip pile was 195 000 cfu/m³.

The different types of spores found at the

Table 1
Age, working time, skin prick test, serum antibodies and selected lung functions of eight chip pile and bark pile workers (lung functions as percentages of predicted)

Worker (sex)		Age	Working years	Skin prick test	Serum antibodies	Diffusion capacity %	Vital capacity %
HK ^a	(m)	42	1	-	-	98	106
VH ^a	(m)	47	3.5	-	-	115	117
EM ^b	(f)	48	2.5	+	<i>A. fumigatus</i> 1:4	84	85
MS ^c	(m)	30	4	-	-	97	99
MV ^c	(m)	55	4	-	-	89	95
AM ^c	(m)	51	7	-	-	90	90
LL ^c	(m)	60	7	-	<i>A. fumigatus</i> 1:1	74	94
LE ^{c,d}	(m)	47	12	-	<i>A. fumigatus</i> 1:1	86	78
Workers with antibodies (mean ± SD)						81 ± 6	86 ± 8
Workers without antibodies (mean ± SD)						98 ± 10	101 ± 11

^a bark pile worker.
^b chip conveyor supervisor.
^c chip pile worker.
^d subject with bronchiectasis.

piles are presented in Table 3. The most prevalent species were *Aspergillus fumigatus* and other *Aspergillus* and *Penicillium* species. Altogether 17 different species were identified among yeasts and moulds.

No separate study was done on the spore exposure at the bark piles. The general conditions for microbial growth are similar to those found at the chip pile. However, some differences in the microbial flora are probable, as predicted from the absence of immunological response of the workers in this and another study (A. Linnapuomi, personal communication).

DISCUSSION

High fungal exposure is associated with a risk of extrinsic allergic alveolitis (4). In the cases of farmer's lung in Finland the mouldy hay exposure has ranged between 10⁵ and 10⁶ spores/m³ (M. Kotimaa, personal communication). In the present study the exposure at chip piles varied

mostly between 10⁴ and 10⁵ spores/m³ (Table 2). The insidious subacute development of allergic alveolitis may result from prolonged exposure to low concentrations of fungi (6).

Three of six subjects working on the chip piles showed precipitating serum antibodies against *Aspergillus fumigatus* which is an indication of significant exposure. In the two bark pile workers no antibodies were found, nor in the eight non-exposed control subjects.

Our results are in accordance with another Finnish study where five chip pile and five bark pile workers were examined (A. Linnapuomi, personal communication). On the chip piles four of five workers had precipitating antibodies against moulds (*A. fumigatus* 3/5, *A. umbrosus* 3/5, *T. vulgaris* 1/5). On bark piles none of five workers examined had antibodies.

In Swedish sawmills precipitating antibodies, mostly against *Rhizopus rhizopodiformis*, were found in 55 % of trimming department workers with respiratory symptoms. In the sawmills where no symptoms were recognized only 7 % of wood trimmers had precipitating antibodies (11). A Finnish trimmer with allergic alveolitis had antibodies against *Aspergillus fumigatus* and *Thermoactinomyces vulgaris* (10).

Besides symptoms of typical allergic alveolitis, more long-standing catarrhal respiratory complaints are found in the woodworking environment, for example, in the trimming departments of the sawmills (1). Apart from mould spores, the causative agent could be volatile chemical compounds emitted from the wood, especially in chip piles. Mild upper respiratory irritation may be expected, but these

Table 2
Total spore densities on the chip piles

Wood species	Age of pile in weeks	Total number of spores (cfu/m ³)
Pine	1	291 000
Pine	4	15 700
Birch	1	270
Birch	10	248 000
Birch	16	10 400

Table 3
Spore types and size by type of the chip pile as percentages of total spores

Chip pile	Spore type (%)			Spore size (%)	
	Mesophilic moulds	Thermotolerant moulds	Thermophilic yeasts	< 5 µm	> 5 µm
Pine	44	56	0	47	53
Pine	93	7	0	85	15
Birch	87	0	13	45	55
Birch	44	56	0	51	49
Birch	22	76	2	73	27

chemicals probably have no permanent effect on lung function.

In the antibody-positive subjects there was a tendency toward impaired lung function in the parameters of total diffusion capacity and vital capacity (Table 1). This could indicate a slow progressing broncho-alveolar reaction without acute symptoms of extrinsic allergic alveolitis.

No firm conclusion can be based on such a small study sample. The confounding by selection is possible. Nevertheless, it is obvious that chip pile workers are exposed to substantial amounts of fungal spores. Our study suggests that this exposure results in sensitization and the appearance of precipitating antibodies in many of the workers. Although work-related respiratory symptoms were not readily recognized by the subjects, it cannot be excluded that such exposure may lead to impairment of respiratory performance over the years in some of them. This can only be confirmed in a larger epidemiological survey.

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