

10008 - THE USE OF THE POLYMERASE CHAIN REACTION FOR THE DETECTION OF AIRBORNE *MYCOBACTERIUM TUBERCULOSIS* IN HEALTH CARE SETTING

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Objective : Tuberculosis (TB) has re-emerged as one of major infectious diseases of public health concern. Tubercle bacilli in airborne droplet nuclei produced by person with pulmonary tuberculosis. This study attempts to use a sensitive PCR analytical method coupled to a filter sampling method to detect the presence of airborne *Mycobacterium tuberculosis* in the hospital environment.

Method : The patients selected for this study were identified with clinical diagnoses of tuberculosis. The expired-air via respiratory tube connecting with a ventilator from patient in ICU was filtered using Polycarbonate (PC)/Teflon filters. The air samples were taken through a three-piece cassette from the negative pressure isolation rooms of patients selected for the study. After sampling, these two different filters were analyzed using PCR method.

Results : Sixteen of 32 expired-air samples from the study patients had positive membrane air sampling with PCR analysis, including PC filters (4/16) and Teflon filters (12/16). The indoor air samples of negative pressure isolation rooms of the patients also had positive PCR runs (PC: 10/17, Teflon: 8/17).

Conclusion : We have performed air sampling of expired-air of patients diagnosed for pulmonary tuberculosis and patient isolation rooms. It showed that PCR amplification of the hospital air samples detected the offending pathogens (50%). Indoor air quality of hospital environments will investigate in the future.

Key words : tuberculosis, *Mycobacterium tuberculosis*, filter sampling, polymerase chain reaction analysis

10498 - Daily changes of Peak Expiratory Flow and respiratory symptoms around a soy-processing factory

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This study was undertaken to evaluate acute respiratory health effects and sensitization in inhabitants of the quarters surrounding a soybean oil-producing factory in the city of Utrecht, the Netherlands. A total of 1000 subjects living in the surroundings of the company and 1000 from a control area at the other side of town were asked to respond to a short questionnaire on respiratory symptoms and allergy in order to recruit potential responders for a small panel study. The total response was 18.9% and 108 persons were invited to participate, which resulted in 53 potentially exposed and 30 control subjects. These subjects were asked to participate in skin prick testing for common and soy allergens. Morning and evening PEF were measured and respiratory symptoms and bronchodilator use were recorded daily during a ten week period in the autumn. At the same time soy allergen and endotoxin concentrations were determined in airborne dust; upwind, down wind and in the control neighbourhood. The direction of the wind with respect to the situation of a subjects' house and the factory was used as the exposition parameter for a subject.

Only few of the atopic subjects that were studied were sensitized to soy, while no difference was seen between the study area and the control area. PEF, respiratory symptoms and bronchodilator use showed a decrease, respectively increase among soy-sensitized subjects after exposure to wind from the direction of the factory in an auto-regression analysis accounting for first order auto-correlation. Soy allergen levels were higher in the exposed area compared to the control area, but measurements only showed a weak correlation with the wind direction, probably because other factors (soy related truck traffic in the neighbourhood) determined the exposure in the area as well.

In conclusion: emissions of the soybean oil factory do not seem to cause soy sensitization among atopic subjects, but is associated with increased reporting of symptoms and a decreased PEF among soy-sensitized subjects.

Determinants of bioaerosol and particle exposures among teachers

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Moisture and mould problems of buildings are associated with respiratory symptoms and diseases. The indoor air measurements have shown that both the concentrations and the microflora of the bioaerosol in the indoor air of a damaged building differ from that of a normal building. However, factors that contribute to personal exposures in damage buildings have not intensively investigated to provide information what measures are the most effective in reducing exposures.

A randomly selected sample of 81 elementary school teachers of two cities in eastern Finland were asked to participate in two 24-hour measurement periods of bioaerosol and other particles. The measurements were conducted on wintertime (November 98 - March 99, November - December 99) when a snow cover eliminates outdoor airborne microbes. Personal exposure samples were collected during a 24-hour sampling period by personal exposure monitors. The sampling period of microenvironmental measurements was 24 hours in the homes and 8 hours during a workday in the workplaces. Bioaerosol and particle samples were collected onto a 25 mm PVC filter with a button aerosol sampler (SKC Inc., Eighty Four, PA, USA) with a flow rate of 4 l/min. The sampler has been designed to follow the ACGIH/CEN/ISO inhalable convention curve. The concentration of collected particles was measured by weighing the filters with a microbalance. The reflectances of the filters were measured with Black Smoke method by a smokestain reflectometer. After these measurements the particles were extracted from the filter. Viable microorganisms (fungi and bacteria) of filter were cultured and the total numbers of fungi and bacteria were counted with an epifluorescence microscope after acridine orange staining. At the end of both sampling periods, the teachers filled in a questionnaire concerning the events of the previous 24 hours possibly affecting the exposure. After the both measurements, an extensive background questionnaire of health symptoms and home and work place characters was filled in.

Personal viable bacteria exposures of individuals living in the suburban or on the countryside (median 496 cfu/m³) were significantly higher than exposure of individuals living in the city center (median 292 cfu/m³). Furthermore living in a single family or row house increased significantly viable fungi personal exposures (median 17 cfu/m³) compared to living in an apartment building (median 4.5 cfu/m³). However, there was no differences between total fungi, total bacteria, viable fungi or viable bacteria personal exposures of subjects reporting to have moisture damage, mould growth or smell of mould during previous year and those who did not report to have those problems. Commuting by car or bus during the measurement period seems to increase significantly personal particle mass exposures (median 43.5 µg/m³) and absorption coefficients of personal exposure filters (median 9.8*10⁻⁶/m) compared to personal exposures of those commuting by walk or bike (median of particle mass exposure 35.4 µg/m³, median absorption coefficient of exposure filters 6.1 *10⁻⁶/m) although reporting to live near heavy traffic roads did not have an effect on personal exposures.

10972 - Sampling efficiencies of three bioaerosol samplers for culturable fungi under field conditions

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A field study was undertaken to examine the sampling efficiencies of three bioaerosol samplers. The Andersen N-6, SAS-90 and RCS Standard were chosen for comparison. Sampling sites were offices in public buildings. None of the sites was pre-selected as having an indoor air quality problem. There was a wide range of size, construction and furnishing materials represented. Seventy-five offices were examined from May - October, 2001. Fungal aerosol samples were taken in three rooms within each office (e.g. a common room and two private offices). The outdoor sample was taken near the source of fresh air for the building. Samples were collected in duplicate onto malt extract agar (MEA) in 100 mm petri plates (N-6), 84mm contact plates (SAS) or flexible plastic strips (RCS). Media were incubated for 4 – 5 days prior to counting and identifying the colonies. Fungal concentration data were log-normally distributed and were log transformed for analysis. Data from the three rooms were averaged for each location. There was a high degree of correlation amongst the data from the three samplers ($p < 0.001$). However, there was a significant difference in collection efficiency among the instruments examined ($p < 0.001$). When total fungal concentrations were tallied, $RCS > N-6 > SAS$ for indoor, but $N-6 > RCS > SAS$ for outdoor samples as listed in Table 1.

Table 1. Concentration of culturable airborne fungi recovered by three sampling instruments.

Location	n	N-6 CFU ^a /m ³ GM ^b (GSD) ^c	n	SAS CFU/m ³ GM (GSD)	n	RCS CFU/m ³ GM (GSD)
Inside	75	68 (4.78)*	70	17 (4.42)*	75	119 (2.59)*
Outside	75	692 (2.32)	70	192 (2.69)*	75	556 (1.84)

^a Colony Forming Units per cubic meter

^b Geometric Mean

^c Geometric Standard Deviation

* significantly different $p < 0.001$, Scheffe's post hoc test.

Additionally, there were significant differences in sampling efficiency for fungal groups as listed in Table 2. The N-6 was more likely to detect fungal genera with smaller spores (e.g. *Aspergillus* and *Penicillium*) ($p < 0.001$), while the RCS had a higher efficiency for larger propagules (e.g. yeast) ($p < 0.001$). The recovery efficiency of the SAS-90 was intermediate between the N-6 and the RCS. In addition to concentration, the relative proportion of fungal genera represented must be borne in mind when comparing field data taken with different sampling instruments.

Table 2. Representational proportion of indoor airborne fungal groups identified.

Fungal Groups	N-6 Mean % (SD) ^a	SAS Mean % (SD)	RCS Mean % (SD)	p value
<i>Cladosporium</i>	49 (26)	41 (33)	32 (26)*	0.04
<i>Penicillium</i>	11 (16)*	3.2 (7.4)	2.0 (6.2)	< 0.001
<i>Aspergillus</i>	3.2 (6.8)*	0.3 (1.4)	0.1 (0.5)	< 0.001
Yeast	13 (19)	13 (21)	54 (28)*	< 0.001
Sterile mycelia	17 (19)	12 (19)	7.7 (11)*	0.03

^a Standard Deviation

* significantly different by Scheffe's post hoc test.

11017 - Reliability of indoor allergen measurements repeated after three years in homes in Connecticut and Massachusetts

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Background. Exposure to aeroallergens found in house dust is an important risk factor in allergen sensitization, and exacerbation of symptoms among children with asthma. Dust mite, cockroach, cat and dog are the most common aeroallergens. This study investigates the reliability of exposure to these allergens over time.

Methods. As part of a larger study of environmental risk factors for asthma development and severity, dust samples were collected in the main living area of 383 homes of asthmatic children in Connecticut and southwestern Massachusetts (1997-1998). Samples were analyzed for levels of dust mite (Der p 1 and Der f 1), cockroach (Bla g 1), cat (Fel d 1) and dog (Can f 1) allergen. Homes of the same families were re-sampled, using the identical protocol in 2000-2001. Allergen measurements were categorized in three levels (low, medium, high); $<2\mu\text{g/g}$, $\geq 2\mu\text{g/g}$, $\geq 10\mu\text{g/g}$ for dust mite and dog allergen, $<1\mu\text{g/g}$, $\geq 1\mu\text{g/g}$, $\geq 8\mu\text{g/g}$ for cat allergen and $<1\text{U/g}$, $\geq 1\text{U/g}$, $\geq 4\text{U/g}$ for cockroach allergen. Several factors were considered to explain reliability in allergen concentrations, including moving to a new home, change in pet ownership and season the measurement was made.

Results. When comparing first and second allergen measurements (Table 1), initial low allergen measurements tend to remain low, but there is poor agreement in the medium and high categories, weighted Kappa statistics .14 to .53. Only 28 families had high cockroach levels at the first measurement, and 19 of these (67.8%) were in the low category at the second measurement.

Table 1. Percent of second measurements in agreement with first measurement categories

First measurement	low		medium		high		Weighted Kappa	
	%		%		%			
	All ¹	Same ²	All	Same	All	Same	All	Same
dust mite	70.0	70.1	21.9	22.7	45.2	50.6	0.29	0.33
cockroach	75.2	86.6	13.3	16.7	14.3	25.0	0.16	0.14
cat	79.6	82.4	29.5	28.4	66.2	66.1	0.51	0.53
dog	70.9	71.3	12.5	11.9	72.4	75.3	0.45	0.47

¹Total sample, all families with two measurements (n=383)

²Subsample, family did not move, same house measured twice (n=253)

Of 383 families, 130 (34%) moved, 154 (40%) had allergens measured in a different season and 106 (28%) acquired or lost a pet. Stratifying on these characteristics did not substantially improve agreement between the first and second measurements. When dust mite levels are compared among families that did not move, and had both allergen samples taken in the same season, agreement between measurements was 71.7%, 30.4% and 51.1%, respectively.

Conclusion. Aeroallergens measured in the homes of asthmatic children vary over time. Changes in residence, season and pet ownership may contribute to this variability. Cohort studies may need to make repeated measurements to estimate children's exposure.

Words (including Table 1): 470

11030 - Exposure to Bioaerosols in 100 Large U.S. Office Buildings
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USEPA conducted the Building Assessment Survey and Evaluation (BASE) study from 1994–1998 to collect baseline information on environmental factors, building characteristics, and occupants' perceptions of comfort. In this cross-sectional study, data were collected in buildings selected randomly, without regard to IAQ complaints. Offices in 25 states were stratified into 10 climate zones and studied once in summer or winter. Bioaerosol data (collected indoors and outdoors) included air samples (culturable fungi and bacteria, and fungal spores), wet and dry source samples (culturable fungi and bacteria), and dust samples (cat and dust mite allergens). This paper presents summary statistics for these data. Samples of airborne bacteria were collected with Andersen samplers and incubated at two temperatures (30°C and 55°C) for 5 bacterial groups: Gram-positive rods, Gram-positive cocci, Gram-negative rods, Gram-negative cocci, and unknown bacteria. Airborne fungi were collected with Andersen and Burkard samplers. Fifty-eight fungal groups were identified (28, culture only; 13, direct examination only; 17, both methods). Air concentrations were compared by sampling location (indoors/outdoors), season (summer/winter), and climate zone (temperature/humidity). Total bacterial concentrations generally were higher and more variable outdoors but similar in summer and winter. Indoor concentrations showed more seasonal variation but were similar across all climate zones. Mesophilic bacteria accounted for >80% of total bacteria both indoors and outdoors. Airborne fungi were found more often outdoors and in summer. Outdoors, fungi generally were found more often in regions with warmer winter temperatures, and indoors, in regions with moderate winters. No consistent patterns were observed for summer temperature or humidity. Bacteria were isolated from more dry (~30%) than wet (~10%) bulk samples, and concentrations of mesophilic bacteria again were much higher than thermophiles. Gram-positive rods and cocci were the most abundant mesophilic bacteria in dry bulk samples (~25% each); whereas, Gram-positive rods comprised a larger fraction (~40%) of bacteria in wet samples and Gram-positive cocci a smaller fraction (10%). *Bacillus* species (~50%) and actinomycetes (~20%) accounted for the majority of thermophilic bacteria in bulk samples. The concentrations of cat (*Fel d1*) and dust mite (*Der f1* and *Der p1*) allergens were measured in 93 buildings. *Fel d1* was detected in more than 90% of samples, but exceeded 8 µg/g (a sensitization threshold) in only two buildings. *Der f1* and *Der p1* were found in approximately half of the samples. Mite allergen exceeded 2 µg/g (a sensitization threshold) in five buildings and 10 µg/g (a symptom threshold) in three of those buildings. Mean *Fel d1* concentrations were significantly higher in summer. This evaluation of the BASE bioaerosol data has identified patterns in the occurrence of culturable microorganisms that could be explained by season and climate. Other researchers are invited to explore this valuable database to evaluate associations between biological and other parameters (e.g., building design and operation and occupant

perceptions of the indoor environment).

11091 - Predictors of elevated levels of dust mite, cockroach, cat and dog allergen in the bedding of infants and asthmatic children.

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Background: Exposure to aeroallergens in house dust has been identified as an important environmental risk factor in allergen sensitization and exacerbation of symptoms in asthmatics. Allergen levels in bedding are particularly important because of the time spent sleeping. We measured allergen concentrations in the bedding of infants at risk for developing asthma and their asthmatic siblings, and compared levels with bedding characteristics. Methods: As part of a study of the role of environmental factors in asthma development and severity; dust mite, cockroach, cat and dog allergen levels were measured in the bedding of 999 infants (2 to 5 months of age) and their asthmatic siblings, ages 3 to 7. The study population was drawn from Connecticut and bordering areas from 1996 to 1998. Information on household characteristics (income, mother's education); bedroom characteristics (type of floor covering, presence of drapes or curtains, humidifier use, reported mold or mildew, and presence of cats or dogs); and bedding characteristics (new or used mattress, plastic encased mattress, number of layers of bedding, number of stuffed animals on bed and whether bedding was washed in hot water) was obtained at the time of dust sampling. The analysis employed lower and upper cut points for Group 1 dust mite ($\geq 2.0 \mu\text{g/g}$ and $\geq 10 \mu\text{g/g}$), cockroach ($\geq 1.0 \text{ U/g}$ and $\geq 4.0 \text{ U/g}$), cat ($\geq 1.0 \mu\text{g/g}$ and $\geq 8.0 \text{ ug/g}$) and dog ($\geq 2.0 \mu\text{g/g}$ and $\geq 10.0 \mu\text{g/g}$) allergen in the bedding. The lower cut point is associated with allergen sensitization while the upper cut point is associated with the exacerbation of asthma in sensitized individuals. All models controlled for income and mother's education. Results: Median concentrations for all allergens were higher in the asthmatics' than infants' bedding. Dust mite, cockroach, cat and dog allergen sensitization levels were exceeded in 34.0%, 15.6%, 36.4% and 30.9% of the infants' bedding, respectively; exacerbation levels for each of the allergens was exceeded in 18.8%, 15.7%, 20.6% and 22.5% of the asthmatics' bedding, respectively. Measures intended to reduce allergen levels (new mattress, plastic encased mattress, reducing stuffed animals on bed, and washing bedding in hot water) were not associated with having allergen levels below sensitization levels ($p > 0.05$) in the infants' bedding or below the exacerbation level in asthmatics' bedding. Preventing animals from entering the bedroom reduced the likelihood of having cat and dog allergen in excess of the exacerbation level in the asthmatic bedding and of having dog allergen in excess of the sensitization level in the infant bedding ($p \leq 0.05$). Conclusion: Conventional efforts to maintain allergen levels in bedding below levels associated with sensitization and asthma exacerbation levels may not be effective.