



2012 Number 1

# ISIAQ NEWSLETTER

March 2012

## Only Four Months until Healthy Buildings 2012 – “HB2012” July 8-12, Brisbane, Australia

ISIAQ’s Healthy Buildings 2012 conference is less than four months away. If you have not yet made plans to attend, it is time to consider seriously whether you can afford to miss this important conference.

The Healthy Buildings conference series was started in 1988 to focus on translation of research results into their practical implications. ISIAQ began sponsoring the conference series which fits squarely within ISIAQ’s mission to address the needs of practitioners as well as researchers and policy makers around the world.

Organizers expect approximately 600 papers to be presented on a wide range of topics. The paper review process is almost completed and the actual number of scheduled presentations will be known soon.

The conference will include three symposia as integral parts of the program:

Symposia I: Balance of Power: Energy Conservation versus Indoor Environment Quality

Symposia II: Race against Time: Population, Urban Growth and Miracles of Technology

Symposia III: Infection Spread: Will breathing kill you?

ISIAQ’s Annual General Meeting will take place during the conference. The Board of Directors will meet on Saturday immediately prior to the conference. All Scientific and Technical Committees will meet on Sunday afternoon, immediately before the Opening Ceremony.

Information on the conference is available on the conference web site, [www.HB2012.org](http://www.HB2012.org).

## Members approve revision of By-laws

The Society Members have overwhelmingly approved the By-law revision sent out for ballot in late February. Comments were received from four members, only one of whom voted against the revision of the By-laws.

The current version of the ISIAQ By-laws can be read on-line on the ISIAQ web page or downloaded from the web site. To view the By-laws at any time, visit the “About Us” section or the Publications page of the ISIAQ web site.

The ISIAQ By-laws can be found at <http://www.isiaq.org/publications/By-laws-ApprovedFebruary2012Final.pdf>.

## Small By-law revision still needed

A small additional revision will be sent out for ballot on March 15. It will modify the amount of time prior to the annual general meeting a nomination for the Board of Directors must be received by the Secretariat. The current requirement is 90 days in advance of the AGM, the proposed revision would change that to 75 days.

## Board of Directors hold first “Retreat”

In January, in a cold, snow-covered Chicago, the ISIAQ Board of Directors met for two days in its first ever “retreat.” The purpose of the retreat was to discuss the long term policy directions and future of the Society. Many issues were covered. The Board will report on the retreat at the Annual General Meeting in Brisbane.

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## **Indoor Air, Volume 22, Number 1 February 2012**

### **Abstracts**

#### **Ellison Carter, C. Matt Earnest, Elliott T. Gall and Brent Stephens - Progress and priorities in reducing indoor air pollution in developing countries**

A call to action for governments, institutions, corporations, and individuals worldwide to reduce the deadly effects of indoor air pollution (IAP) in developing countries was published in this journal 6 years ago (*Indoor Air*, 2–3, 2006), and the issue is no less urgent today. Nearly half the world's population still depends on solid fuels to meet their basic household energy needs. Exposure to pollutants from inefficient burning of solid fuel indoors for cooking, heating, and lighting accounts for a significant proportion of the global burden of disease. The World Health Organization estimates that nearly 2 million people die prematurely each year from exposure to IAP. Women and young children disproportionately shoulder the burden of adverse health effects. Unless swift and effective action is taken, the health risks associated with IAP are projected to rise as the number of people using these fuels increases.

#### **A. Roy, R. S. Chapman, W. Hu, F. Wei, X. Liu and J. Zhang - Indoor air pollution and lung function growth among children in four Chinese cities**

**Abstract** Ambient air pollution has been associated with decreased growth in lung function among children; but little is known about the impact of indoor air pollution. We examined relationships between indoor air pollution metrics and lung function growth, among children ( $I = 3273$ ) aged 6–13 years living in four Chinese cities. Lung function parameters (FVC and FEV<sub>1</sub>) were measured twice a year. Questionnaires were used to determine home coal burning and ventilation practices. Generalized estimating equations were used to examine associations. Use of coal as a household fuel was associated with 16.5 ml/year lower (33%,  $P < 0.001$ ) and 20.5 ml/year lower (39%,  $P < 0.001$ ) growth in children's FEV<sub>1</sub> and FVC, respectively. FEV<sub>1</sub> growth was 10.2 ml/year higher (20%,  $P = 0.009$ ), and FVC growth was 17.0 ml/year higher (33%,  $P < 0.001$ ) among children who lived in houses with the presence of a ventilation device. Among children living in houses where coal was used as a fuel and no ventilation devices were present, adjusted FVC and FEV<sub>1</sub> growth, respectively, were 37% and 61% that of the average growth per year in the full cohort. This suggests that household coal use may cause deficits in lung function growth, while using ventilation devices may be protective of lung development.

**Practical Implications** Nearly 3.4 billion people use solid fuels in homes for cooking and/or heating. We report the following findings from a longitudinal study: (i) household coal use is significantly associated with reduction in children's lung function growth and (ii) the use of household ventilation devices is significantly associated with higher lung function growth, particularly among children living in households where coal is used as a fuel. These findings not only provide evidence that indoor coal use impairs children's lung development but also point to the importance of improving ventilation conditions in reducing harmful effects of indoor air pollution sources.

#### **P. Fabian, G. Adamkiewicz and J. I. Levy - Simulating indoor concentrations of NO<sub>2</sub> and PM<sub>2.5</sub> in multifamily housing for use in health-based intervention modeling**

**Abstract** Residents of low-income multifamily housing can have elevated exposures to multiple environmental pollutants known to influence asthma. Simulation models can characterize the health implications of changing indoor concentrations, but quantifying the influence of interventions on concentrations is challenging given complex airflow and source characteristics. In this study, we simulated concentrations in a prototype multifamily building using CONTAM, a multizone airflow and contaminant transport program. Contaminants modeled included PM<sub>2.5</sub> and NO<sub>2</sub>, and parameters included stove use, presence and operability of exhaust fans, smoking, unit level, and building leakiness. We developed regression models to explain variability in CONTAM outputs for individual sources, in a manner that could be utilized in simulation modeling of health outcomes. To evaluate our models, we generated a database of 1000 simulated households with characteristics consistent with Boston public housing developments and residents and compared the predicted levels of NO<sub>2</sub> and PM<sub>2.5</sub> and their correlates with the literature. Our analyses demonstrated that CONTAM outputs could be readily explained by available parameters ( $R^2$  between 0.89 and 0.98 across models), but that one-compartment box models would mischaracterize concentrations and source contributions. Our study quantifies the key drivers for indoor concentrations in multifamily housing and helps to identify opportunities for interventions.

**Practical Implications** Many low-income urban asthmatics live in multifamily housing that may be amenable to ventilation-related interventions such as weatherization or air sealing, wall and ceiling hole repairs, and exhaust fan installation or repair, but such interventions must be designed carefully given their cost and their offsetting effects on energy savings as well as indoor and outdoor pollutants. We developed models to take into account the complex behavior of airflow patterns in multifamily buildings, which can be used to identify and evaluate environmental and non-environmental interventions targeting indoor air pollutants which can trigger asthma exacerbations.

**C.-M. Chen, E. Thiering, G. Doekes, J.-P. Zock, I. Bakolis, D. Norbäck, J. Sunyer, S. Villani, G. Verlato, M. Täubel, D. Jarvis and J. Heinrich - Geographical variation and the determinants of domestic endotoxin levels in mattress dust in Europe**

**Abstract** Endotoxin exposures have manifold effects on human health. The geographical variation and determinants of domestic endotoxin levels in Europe have not yet been extensively described. To investigate the geographical variation and determinants of domestic endotoxin concentrations in mattress dust in Europe using data collected in the European Community Respiratory Health Survey follow-up (ECRHS II). Endotoxin levels were measured in mattress dust from 974 ECRHS II participants from 22 study centers using an immunoassay. Information on demographic, lifestyle, and housing characteristics of the participants was obtained in face-to-face interviews. The median endotoxin concentration in mattress dust ranged from 772 endotoxin units per gram (EU/g) dust in Reykjavik, Iceland, to 4806 EU/g in Turin, Italy. High average outdoor summer temperature of study center, cat or dog keeping, a high household crowding index, and visible damp patches in the bedroom were significantly associated with a higher endotoxin concentrations in mattress dust. There is a large variability in domestic endotoxin levels across Europe. Average outdoor summer temperature of study center, which explains only 10% of the variation in domestic endotoxin level by center, is the strongest meteorological determinant. The observed variation needs to be taken into account when evaluating the health effects of endotoxin exposures in international contexts.

**Practical Implications** The incoherent observations of the health effects of endotoxin may be partly owing to the geographical heterogeneity of endotoxin exposure. Therefore, the observed variation should be considered in further studies. Measurements of indoor endotoxin are recommended as an indicator for the level of exposures of individual domestic environments.

**Q. Zhang and Y. Zhu - Characterizing ultrafine particles and other air pollutants at five schools in South Texas**

**Abstract** This study examined five schools with different ventilation systems in both urban and rural areas in South Texas. Total particle number concentration, ultrafine particle (UFP, diameter < 100 nm) size distribution, PM<sub>2.5</sub>, and CO<sub>2</sub> were measured simultaneously inside and outside of various school microenvironments. Human activities, ventilation settings, and occupancy were recorded. The study found a greater variation of indoor particle number concentration ( $0.6 \times 10^3$ – $29.3 \times 10^3$  #/cm<sup>3</sup>) than of outdoor ( $1.6 \times 10^3$ – $16.0 \times 10^3$  #/cm<sup>3</sup>). The most important factors affecting indoor UFP levels were related to various indoor sources. Gas fan heaters increased the indoor-to-outdoor ratio (I/O ratio) of total particle number concentrations to 30.0. Food-related activities, cleaning, and painting also contributed to the increased indoor particle number concentration with I/O ratios larger than 1.0. Without indoor sources, the I/O ratios for total particles varied from 0.12 to 0.66 for the five ventilation systems studied. The I/O ratio decreased when the outdoor total particle number concentration increased. Particles with diameters <60 nm were less likely to penetrate and stay airborne in indoor environments than larger particles and were measured with smaller I/O ratios.

**Practical Implications** From an exposure assessment perspective, schools are important and little-studied microenvironments where students congregate and spend a large proportion of their active time. This study provides information for indoor and outdoor ultrafine particle concentrations at different types of school microenvironments. These data may allow future epidemiological studies to better estimate exposure and assess ultrafine particles' health effects among students.

### **C. J. Cros, G. C. Morrison, J. A. Siegel and R. L. Corsi - Long-term performance of passive materials for removal of ozone from indoor air**

**Abstract** The health effects associated with exposure to ozone range from respiratory irritation to increased mortality. In this paper, we explore the use of three green building materials and an activated carbon (AC) mat that remove ozone from indoor air. We studied the effects of long-term exposure of these materials to real environments on ozone removal capability and pre- and post-ozonation emissions. A field study was completed over a 6-month period, and laboratory testing was intermittently conducted on material samples retrieved from the field. The results show sustained ozone removal for all materials except recycled carpet, with greatest ozone deposition velocity for AC mat (2.5–3.8 m/h) and perlite-based ceiling tile (2.2–3.2 m/h). Carbonyl emission rates were low for AC across all field sites. Painted gypsum wallboard and perlite-based ceiling tile had similar overall emission rates over the 6-month period, while carpet had large initial emission rates of undesirable by-products that decayed rapidly but remained high compared with other materials. This study confirms that AC mats and perlite-based ceiling tile are viable surfaces for inclusion in buildings to remove ozone without generating undesirable by-products.

**Practical implications** The use of passive removal materials for ozone control could decrease the need for, or even render unnecessary, active but energy consuming control solutions. In buildings where ozone should be controlled (high outdoor ozone concentrations, sensitive populations), materials specifically designed or selected for removing ozone could be implemented, as long as ozone removal is not associated with large emissions of harmful by-products. We find that activated carbon mats and perlite-based ceiling tiles can provide substantial, long-lasting, ozone control.

### **M. Ongwadee and P. Sawanyapanich - Influence of relative humidity and gaseous ammonia on the nicotine sorption to indoor materials**

**Abstract** Sorption of nitrogen-containing organic constituents of environmental tobacco smoke may be influenced by ammonia, a common indoor gas, and relative humidity (RH). We quantified sorption kinetics and equilibria of nicotine with stainless steel, cotton–polyester curtain, and polypropylene carpet at 0%, 50%, and 90% RH and in the presence of ammonia using a 10-l stainless steel chamber. Nicotine was introduced into the chamber by flash evaporating 50  $\mu$ l of pure liquid. Kinetic sorption parameters were determined by fitting a mass balance model to experimental results using a nonlinear regression. Results show that an equilibrium partition coefficient,  $k_e$ , of nicotine tended to increase as the RH increased for the curtain and carpet. Adsorbed water may contribute to an increase in available sites for nicotine sorption on the surface. In the presence of 20- and 40-ppm  $\text{NH}_3$ , the values of  $k_e$  for carpet were decreased by 14–40% at 50% and 90% RH, but the effect of  $\text{NH}_3$  was not observed at 0% RH. The values of  $k_e$  ranged from 54 to 152 m. Our findings indicate the relative importance of nicotine sorption to surfaces is dependent on the relative humidity and the presence of ammonia.

**Practical Implications** This research demonstrates that relative humidity and gaseous ammonia can influence nicotine sorption to common indoor surfaces, i.e., curtains and carpets. Increasing the relative humidity from dry to modest appears to enhance the sorptive capacity. Presence of the typical range of gaseous ammonia concentrations can reduce the nicotine sorption in a humid environment but does not affect the sorptive capacity in the absence of added water. Thus, studies on the dynamic sorption of other alkaloids or amine constituents of environmental tobacco smoke to indoor surfaces should consider the impact of water vapor concentration because of the interaction of water with the surface and sorbates. Furthermore, the mixture of gaseous amines may participate in adsorption site competition.

### **I. Olmedo, P. V. Nielsen, M. Ruiz de Adana, R. L. Jensen and P. Grzelecki - Distribution of exhaled contaminants and personal exposure in a room using three different air distribution strategies**

**Abstract** The level of exposure to human exhaled contaminants in a room depends not only on the air distribution system but also on people's different positions, the distance between them, people's activity level and height, direction of exhalation, and the surrounding temperature and temperature gradient. Human exhalation is studied in detail for different distribution systems: displacement and mixing ventilation as well as a system without mechanical ventilation. Two thermal manikins breathing through the mouth are used to simulate the exposure to human exhaled contaminants. The position and distance between the manikins are changed to study the influence on the level of exposure. The results show

that the air exhaled by a manikin flows a longer distance with a higher concentration in case of displacement ventilation than in the other two cases, indicating a significant exposure to the contaminants for one person positioned in front of another. However, in all three cases, the exhalation flow of the source penetrates the thermal plume, causing an increase in the concentration of contaminants in front of the target person. The results are significantly dependent on the distance and position between the two manikins in all three cases.

**Practical Implications** Indoor environments are susceptible to contaminant exposure, as contaminants can easily spread in the air. Human breathing is one of the most important biological contaminant sources, as the exhaled air can contain different pathogens such as viruses and bacteria. This paper addresses the human exhalation flow and its behavior in connection with different ventilation strategies, as well as the interaction between two people in a room. This is a key factor for studying the airborne infection risk when the room is occupied by several persons. The paper only takes into account the airborne part of the infection risk.

### **J.-I. Choi and J. R. Edwards - Large-eddy simulation of human-induced contaminant transport in room compartments**

**Abstract** A large-eddy simulation is used to investigate contaminant transport owing to complex human and door motions and vent-system activity in room compartments where a contaminated and clean room are connected by a vestibule. Human and door motions are simulated with an immersed boundary procedure. We demonstrate the details of contaminant transport owing to human- and door-motion-induced wake development during a short-duration event involving the movement of a person (or persons) from a contaminated room, through a vestibule, into a clean room. Parametric studies that capture the effects of human walking pattern, door operation, over-pressure level, and vestibule size are systematically conducted. A faster walking speed results in less mass transport from the contaminated room into the clean room. The net effect of increasing the volume of the vestibule is to reduce the contaminant transport. The results show that swinging-door motion is the dominant transport mechanism and that human-induced wake motion enhances compartment-to-compartment transport.

**Practical Implications** The effect of human activity on contaminant transport may be important in design and operation of clean or isolation rooms in chemical or pharmaceutical industries and intensive care units for airborne infectious disease control in a hospital. The present simulations demonstrate details of contaminant transport in such indoor environments during human motion events and show that simulation-based sensitivity analysis can be utilized for the diagnosis of contaminant infiltration and for better environmental protection.

## *Indoor Air, Volume 22, Number 2 April 2012* *Abstracts*

### **John D. Spengler - Climate change, indoor environments, and health**

For many of us working in the indoor air sciences, it is clear that climate change has implications to buildings beyond modifying cooling and heating demands. Thus, it is surprising that in the world of climate science and policy, so little is said about how extreme weather events and long-term climate conditions might affect health through modification of indoor environments. Even in the most recent *Intergovernmental Panel on Climate Change report (IPCC, 2007a)*, there is only brief reference to indoor health risk in terms of occupational heat stress and possible co-benefits of reducing biomass fuel use. The health concerns that climate scientists have focused on include ecosystem disruption and zoonoses, toxic algal blooms, vector-borne diseases, heat stress, crop losses, and diminished nutritional value of food. Meanwhile, the indoor environment, until recently, has not been considered.

### **S. Karjalainen - Thermal comfort and gender: a literature review**

**Abstract** This review examines scientific literature on the effect of gender on indoor thermal comfort. Gender differences have been generally considered to be small and insignificant but this review shows that a growing number of studies have found significant differences in thermal comfort between the genders. Clearly more than half of the

laboratory and field studies have found that females express more dissatisfaction than males in the same thermal environments. Very few studies have found males to be more dissatisfied than females. A meta-analysis shows that females are more likely than males to express thermal dissatisfaction (ratio: 1.74, 95% confidence interval: 1.61–1.89). However, most studies found no significant difference in neutral temperatures between the genders. Females are more sensitive than males to a deviation from an optimal temperature and express more dissatisfaction, especially in cooler conditions.

**Practical Implications** We should no longer neglect the more rigorous requirements that females have for indoor thermal environments. Gender differences indicate that females have, on average, a greater need for individual temperature control and adaptive actions than males. The results of this review suggest that females should primarily be used as subjects when examining indoor thermal comfort requirements, as if females are satisfied it is highly probable that males are also satisfied.

### **J. Yu, Q. Ouyang, Y. Zhu, H. Shen, G. Cao and W. Cui - A comparison of the thermal adaptability of people accustomed to air-conditioned environments and naturally ventilated environments**

**Abstract** It has been reported previously that people who are acclimated to naturally ventilated (NV) environments respond to hot and warm environments differently than people who are acclimated to air-conditioned (AC) environments. However, it is not clear whether physiological acclimatization contributes to this discrepancy. To study whether living and working in NV or AC environments for long periods of time can lead to different types of physiological acclimatization, and whether physiological acclimatization has an important influence on people's responses of thermal comfort, measurements of physiological reactions (including skin temperature, sweat rate, heart rate variability, and heat stress protein 70) and thermal comfort responses were conducted in a 'heat shock' environment (climate chamber) with 20 people (10 in the NV group and 10 in the AC group). The results showed that the NV group had a significantly stronger capacity for physiological regulation to the heat shock than the AC group. In other words, the NV group did not feel as hot and uncomfortable as the AC group did. These results strongly indicate that living and working in indoor thermal environments for long periods of time affects people's physiological acclimatization. Also, it appears that long-term exposure to stable AC environments may weaken people's thermal adaptability.

**Practical Implications** This study examined the psychological and physiological differences of thermal adaptability of people used to air-conditioned environments and naturally ventilated environments. The results suggested that long-term exposure to stable air-conditioned environments may weaken people's thermal adaptability. Therefore, it might be advantageous for people to spend less time in static air-conditioned environments; this is not only because of its possible deleterious impact on people's physiological adaptability, but also because the air-conditioners' high-energy consumption will contribute to the effects of global warming.

### **M. Frontczak, S. Schiavon, J. Goins, E. Arens, H. Zhang and P. Wargoeki - Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design**

**Abstract** The article examines which subjectively evaluated indoor environmental parameters and building features mostly affect occupants' satisfaction in mainly US office buildings. The study analyzed data from a web-based survey administered to 52 980 occupants in 351 office buildings over 10 years by the Center for the Built Environment. The survey uses 7-point ordered scale questions pertaining to satisfaction with indoor environmental parameters, workspace, and building features. The average building occupant was satisfied with his/her workspace and building. Proportional odds ordinal logistic regression shows that satisfaction with all 15 parameters listed in the survey contributed significantly to overall workspace satisfaction. The most important parameters were satisfaction with amount of space (odds ratio OR 1.57, 95% CI: 1.55–1.59), noise level (OR 1.27, 95% CI: 1.25–1.29), and visual privacy (OR 1.26, 95% CI: 1.24–1.28). Satisfaction with amount of space was ranked to be most important for workspace satisfaction, regardless of age group (below 30, 31–50 or over 50 years old), gender, type of office (single or shared offices, or cubicles), distance of workspace from a window (within 4.6 m or further), or satisfaction level with workspace (satisfied or dissatisfied). Satisfaction with amount of space was not related to the gross amount of space available per person.

**Practical Implications** To maximize workspace satisfaction, designer should invest in aspects that increase satisfaction with amount of space and storage, noise level, and visual privacy. Office workers will be most satisfied with their

workspace and building when located close to a window in a private office. This may affect job satisfaction, work performance, and personal and company productivity.

**E. L. Murray, L. Brondi, D. Kleinbaum, J. E. McGowan, C. Van Mels, W. A. Brooks, D. Goswami, P. B. Ryan, M. Klein and C. B. Bridges - Cooking fuel type, household ventilation, and the risk of acute lower respiratory illness in urban Bangladeshi children: a longitudinal study**

**Abstract** Acute lower respiratory illnesses (ALRI) are the leading cause of death among children <5 years. Studies have found that biomass cooking fuels are an important risk factor for ALRI. However, few studies have evaluated the influence of natural household ventilation indicators on ALRI. The purpose of this study was to assess the association between cooking fuel, natural household ventilation, and ALRI. During October 17, 2004–September 30, 2005, children <5 years living in a low-income neighborhood of Dhaka, Bangladesh, were assessed weekly for ALRI and surveyed quarterly about biomass fuel use, electric fan ownership, and natural household ventilation (windows, ventilation grates, and presence of a gap between the wall and ceiling). Bivariate and multivariate analyses were performed using generalized estimating equations. Six thousand and seventy-nine children <5 years enrolled during the study period (99% participation) experienced 1291 ALRI. In the multivariate model,  $\geq 2$  windows [OR = 0.75, 95% CI = (0.58, 0.96)], ventilation grates [OR = 0.80, 95% CI = (0.65, 0.98)], and not owning an electric fan [OR = 1.50, 95% CI = (1.21, 1.88)] were associated with ALRI; gap presence and using biomass fuels were not associated with ALRI. Structural factors that might improve household air circulation and exchange were associated with decreased ALRI risk. Improved natural ventilation might reduce ALRI among children in low-income families.

**Practical Implications** The World Health Organization has stated that controlling pneumonia is a priority for achieving the fourth Millennium Development Goal, which calls for a two-third reduction in mortality of children <5 years old compared to the 1990 baseline. Our study represents an important finding of a modifiable risk factor that might decrease the burden of respiratory illness among children living in Bangladesh and other low-income settings similar to our study site. We found that the existence of at least two windows in the child's sleeping room was associated with a 25% decreased ALRI risk. Increasing available natural ventilation within the household in similar settings has the potential to reduce childhood mortality because of acute lower respiratory illnesses.

**L. G. Pruneda-Álvarez, F. J. Pérez-Vázquez, M. Salgado-Bustamante, R. I. Martínez-Salinas, N. A. Pelallo-Martínez and I. N. Pérez-Maldonado - Exposure to indoor air pollutants (polycyclic aromatic hydrocarbons, toluene, benzene) in Mexican indigenous women**

**Abstract** Indoor air pollution is considered to be a serious public health issue in Mexico; therefore, more studies regarding this topic are necessary. In this context, we assessed exposure to polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds in: (i) women who use firewood combustion (indoor) for cooking and heating using traditional open fire; (ii) women who use firewood combustion (outdoor) for cooking and heating using traditional open fire; and (iii) women who use LP gas as the principal energy source. We studied 96 healthy women in San Luis Potosí, México. Urine samples were collected, and analyses of the following urinary exposure biomarkers were performed by high-performance liquid chromatography: 1-hydroxypyrene (1-OHP), trans, trans-muconic acid, and hippuric acid (HA). The highest levels of 1-OHP, trans, trans-muconic acid, and HA were found in communities where women were exposed to indoor biomass combustion smoke (or products; geometric mean  $\pm$  s.d.,  $3.98 \pm 5.10$   $\mu\text{mol/mol}$  creatinine;  $4.81 \pm 9.60$   $\mu\text{g/l}$  1-OHP;  $0.87 \pm 1.78$   $\text{mg/g}$  creatinine for trans, trans-muconic acid; and  $1.14 \pm 0.91$   $\text{g/g}$  creatinine for HA). Our findings indicate higher exposure levels to all urinary exposure biomarkers studied in women who use indoor firewood combustion for cooking and heating (using traditional open fire).

**Practical Implications** High mean levels of 1-hydroxypyrene, t,t-muconic acid, and hippuric acid were found in women who use firewood combustion (indoor) for cooking and heating using traditional open fire and taking into account that millions of women and children in Mexico are living in scenarios similar to those studied in this report, the assessment of health effects in women and children exposed to polycyclic aromatic hydrocarbons and volatile organic compounds is urgently needed. Moreover, it is immediately necessary an intervention program to reduce exposure.

**S. Oeder, S. Dietrich, I. Weichenmeier, W. Schober, G. Pusch, R. A. Jörres, R. Schierl, D. Nowak, H. Fromme, H. Behrendt and J. T. M. Buters - Toxicity and elemental composition of particulate matter from outdoor and indoor air of elementary schools in Munich, Germany**

**Abstract** Outdoor particulate matter (PM<sub>10</sub>) is associated with detrimental health effects. However, individual PM<sub>10</sub> exposure occurs mostly indoors. We therefore compared the toxic effects of classroom, outdoor, and residential PM<sub>10</sub>. Indoor and outdoor PM<sub>10</sub> was collected from six schools in Munich during teaching hours and in six homes. Particles were analyzed by scanning electron microscopy and X-ray spectroscopy (EDX). Toxicity was evaluated in human primary keratinocytes, lung epithelial cells and after metabolic activation by several human cytochromes P450. We found that PM<sub>10</sub> concentrations during teaching hours were 5.6-times higher than outdoors ( $117 \pm 48 \mu\text{g}/\text{m}^3$  vs.  $21 \pm 15 \mu\text{g}/\text{m}^3$ ,  $P < 0.001$ ). Compared to outdoors, indoor PM contained more silicate (36% of particle number), organic (29%, probably originating from human skin), and Ca-carbonate particles (12%, probably originating from paper). Outdoor PM contained more Ca-sulfate particles (38%). Indoor PM at  $6 \mu\text{g}/\text{cm}^2$  ( $10 \mu\text{g}/\text{ml}$ ) caused toxicity in keratinocytes and in cells expressing CYP2B6 and CYP3A4. Toxicity by CYP2B6 was abolished with the reactive oxygen species scavenger *N*-acetylcysteine. We concluded that outdoor PM<sub>10</sub> and indoor PM<sub>10</sub> from homes were devoid of toxicity. Indoor PM<sub>10</sub> was elevated, chemically different and toxicologically more active than outdoor PM<sub>10</sub>. Whether the effects translate into a significant health risk needs to be determined. Until then, we suggest better ventilation as a sensible option.

**Practical Implications** Indoor air PM<sub>10</sub> on an equal weight base is toxicologically more active than outdoor PM<sub>10</sub>. In addition, indoor PM<sub>10</sub> concentrations are about six times higher than outdoor air. Thus, ventilation of classrooms with outdoor air will improve air quality and is likely to provide a health benefit. It is also easier than cleaning PM<sub>10</sub> from indoor air, which has proven to be tedious.

**Z. Wang, S. L. Shalat, K. Black, P. J. Liroy, A. A. Stambler, O. H. Emoekpere, M. Hernandez, T. Han, M. Ramagopal and G. Mainelis - Use of a robotic sampling platform to assess young children's exposure to indoor bioaerosols**

**Abstract** Indoor exposures to allergens, mold spores, and endotoxin have been suggested as etiological agents of asthma; therefore, accurate determination of those exposures, especially in young children (6–36 months), is important for understanding the development of asthma. Because use of personal sampling equipment in this population is difficult, and in children <1 year of age impossible, we developed a personal sampling surrogate: the Pretoddler Inhalable Particulate Environmental Robotic (PIPER) sampler to better estimate their exposures. During sampling, PIPER simulates the activity patterns, speed of motion, and the height of the breathing zones of young children, and mechanically resuspends the deposited dust just as a young child does during running and crawling. The concentrations of allergens, mold spores, and endotoxin measured by PIPER were compared to those measured using traditional stationary air sampling method in 75 homes in central New Jersey, United States. Endotoxin was detected in all homes with median concentrations of 1.0 and 0.55 EU/m<sup>3</sup> for PIPER and stationary sampler, respectively. The difference in median concentrations obtained using the two methods was statistically significant for homes with carpeted floors ( $I = 0.0001$ ) in the heating season. For such homes, the average ratio of endotoxin concentration measured by PIPER to the stationary sampler was 2.96 (95% CI 2.29–3.63). Fungal spores were detected in all homes, with median fungal concentrations of 316 and 380 spores/m<sup>3</sup> for PIPER and stationary sampler, respectively. For fungi, the difference between the two sampling methods was not statistically significant. For both sampling methods, the total airborne mold levels were statistically significantly higher in the non-heating season than in the heating season. Allergens were detected in ~15% of investigated homes. The data indicate that the traditional stationary air-sampling methods may substantially underestimate personal exposures to endotoxin, especially due to resuspension of dust from carpeted floor surfaces. A personal sampling surrogate, such as PIPER, is a feasible approach to estimate personal exposures in young children. PIPER should be seriously considered as the sampling platform for future exposure studies in young children.

**Practical Implications** This study investigated potential indoor bioaerosol exposure of young children using a Pretoddler Inhalable Particulate Environmental Robotic (PIPER) sampler platform. The results show that the traditional stationary air-sampling methods can substantially underestimate personal exposures to resuspended material, and that a personal sampling surrogate, such as PIPER, offers a feasible surrogate for measuring personal inhalation exposures of young children.

## About ISIAQ

With more than 900 members from more than 45 countries, ISIAQ is an international, independent, multidisciplinary, scientific, non-profit organization whose purpose is to support the creation of healthy, comfortable and productive indoor environments. We strongly believe this is achievable by advancing the science and technology of indoor air quality and climate as it relates to indoor environmental design, construction, operation and maintenance, air quality measurement and health sciences.

As a Society, our major role is to facilitate international and interdisciplinary communication and information exchange by publishing and fostering publication on indoor air quality and climate. We organize, sponsor and support initiatives such as meetings, conferences, and seminars on indoor air quality and climate; and we develop, adapt and maintain guidelines for the improvement of indoor air quality and climate.

ISIAQ's journal, *Indoor Air*, published six times per year, is the most respected and widely-cited source of scientific information relevant to building scientists and professionals. Our two major international conferences -- the Indoor Air 'xx and the Healthy Buildings 'xx conference series -- set the standard for high quality scientific information and its application to making healthy buildings. We also cooperate with government and other agencies and societies with interests in the indoor environment and climate.

To find out more about us, visit our website: <http://isiaq.org>

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## Corporate Memberships are available

If your organization is involved in indoor air science, policy, or practice, a corporate membership in ISIAQ will place you in the limelight with the international indoor air community.

- ISIAQ reaches more than 45 countries around the world.

- ISIAQ's conferences, considered the most important in the field, have been attended by more than 4,000 individuals.

- The official Society journal, *Indoor Air*, is respected by scientists and policy-makers as the most reliable way to keep up with the latest scientific findings in the field.

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