5 Health Effects

5.1 Infectious diseases

5.1-1 Dispersion of exhalation pollutants in a two-bed hospital ward with downward ventilation system
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A downward ventilation system has been proposed as a standard ventilation design by Centers for Diseases Control and Prevention (CDC) for isolation rooms to reduce the risk of cross infection for airborne transmission diseases. The expected airflow pattern of a downward ventilation design is to supply cool and heavier clean air from a ceiling diffuser to push contaminants down and be removed from outlets at the floor level. It is hoped to produce a ‘laminar’ (strictly speaking should read as unidirectional) flow to avoid mixing and reduce cross infection risk. Experiments were carried out in a full-scale experimental hospital ward with a downward ventilation system to investigate the possibility of applying downward ventilation in a general hospital ward. Two life-sized breathing thermal manikins were used to simulate a source patient and a receiving patient. From our study, this ‘laminar’ air flow pattern was shown to be impossible to be obtained due to the turbulent flow mixing and the flow entrainment into the supply air stream. The thermal plumes above people induced flow mixing. We studied the effects of locations of the supply opening and the extraction opening on the flow pattern and pollutant exposure level in the occupied zone. A number of practical recommendations are made from this study.

5.1-2 Numerical and experimental study of the air distribution in a negative pressure isolation ward
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In healthcare facilities, the proportion of the healthcare professionals affected reached a surprising level during the SARS spreading period in China in 2003. The poor air distribution and ventilation strategy in the existed isolation wards contribute to bad indoor air quality situation. According to an actual negative pressure isolation ward in Beijing, which was used to isolate SARS patients, this paper carried out the numerical simulation and valid experiment to optimize the indoor air distribution for it. The result showed it is an acceptable ventilation system the supply air distributor is placed in one side of the ceiling opposite the patient’s bed-head exhausts when the patient breathes peacefully. But the concentration of contaminant of the Breathing Zone of the Healthcare professionals would reach a high level when the patient is coughing severely although the decay of it would be fast.

5.1-3 Inter-flat air flow and the spread of aerosol transmitted infectious diseases
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In the world-wide scale outbreak of SARS in 2003, cluster of cases occurred in large building blocks, especially in Hong Kong. In this paper, we will examine one of most likely virus-spread mechanisms, which is related to the inter-flat or inter-zonal air flow through open windows caused by buoyancy effects. Both tracer gas technique and CFD (computational fluid dynamics) techniques are employed to quantify the amount of the exhaust air coming out of the upper part of the window of a floor that re-enters the lower part of the open window at the immediate upper floor. The results can well explain the finding that DNA strings of SARS Coronavirus were detected within the sampled deposits on the window sills of the upper floors of the two index patients’ flats. The preliminary and yet alarming conclusion may be that high-rise buildings with flush windows on the same vertical facade can be a major route for the vertical spread of pathogen-containing aerosols.

5.1-4 Sampling and assay of airborne bacteria in the laboratory building
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The purpose of this study was to find the typical concentration levels of bacterial aerosol in a laboratory building. The building was installed an air-conditioning system. Airborne bacteria were collected using the air microorganism sampler Merck-100 inside of the building. It was found that at same time, the concentration of airborne bacteria distributed uniformly in each sample place. It may due to ventilation of the air-conditioning system. When concerned the same place, the concentration of airborne bacteria changed due to people’s moving. The maximal level of airborne bacteria was observed at AM 7:50–8:20. And the percentage of the Gram-positive bacteria was higher than the Gram-negative one. The minimal level of airborne bacteria was at PM 10:00–10:30. At this time, the percentage of the Gram-positive bacteria was equal to the Gram-negative one. The result showed that the people’ moving was the main influence on the concentration of airborne bacteria in this building. When something dangerous happened, the chance of pollution should be uniformed in each place of this building. An important source of Gram-positive bacteria in the indoor environment originated workers outdoors.

5.1-5 Probable roles of bio-aerosol dispersion in some super spreading events during the 2003 SARS epidemics in Hong Kong
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We spend more than 90% of our time indoors, and modern indoor environments are often connected within a large building complex in large
and crowded cities. There has been a growing interest in improving environmental control of droplet/airborne transmitted diseases in buildings and hospitals since the severe acute respiratory syndrome (SARS) epidemics in 2003. SARS virus was considered to be primarily transmitted by large droplets and close contact. However, epidemiological studies also provided probable evidences of airborne transmission for some super spreading events (SSEs) (7) such as the Amoy Gardens outbreak (8,9). An understanding of the factors leading to SSEs is important for preventing the possibly preventable SSE-based transmission in future.

5.1-6 Detection of air samples from the sick-districts of SARS-patients accepted hospital using RT-PCR

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To assess the risk of the sick-districts aerosol infection in SARS-patients accepted hospitals in Beijing, we used Andersen microbial sampler 2 stage (AMS-2) to sample incessantly at five spots (Corridors, Exhaust fans, clean-districts, sickrooms and sickroom-balcony) and obtained 112 air samples in different times. Then we accomplished washing of air samples, isolation of total RNA, RT-PCR, Vero-E6 cells culture and gene-sequencing analysis. We have successfully separated active SARS-CoV (called LK309 strain) from air samples and RNA of SARS-CoV was detected at all five spots in two hospitals, among which the detecting positive rate is 25 (52.1%) of 48 air samples from sickrooms in XiaoTang-hill hospital and is 9 (29.03%) of 31 ones from sickrooms in 309 hospital, the results showed that convalescence patients still exhale viruses by respiratory tract and at 5 to 10m distance the presence of SARS-patients poses a potential hazard of aerosol transmission and infection for other susceptible patients and staff. Vero-E6 cells culture and RT-PCR revealed that air samples is susceptive to disinfector, having lesser resistibility to outer circumstance, so strict disinfections, isolation and ventilation can be a useful method for reducing efforts to control SARS-CoV aerosols in the sick-districts. cDNA sequencing analysis shows that SARS-CoV LK309 strain has not obvious variation located on the N protein.
5.2 Allergies and asthma

5.2.1 Influence of formaldehyde from indoor decoration on buccal cells of the residents in Wuhan

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In this study, 60 families in the same community were investigated. Among these families, 30 were decorated within one year while the corresponding ones decorated at least 4 years ago. Buccal cells donated by people available in these families were employed to carry out single cell gel electrophoresis (SCGE, Comet assay, for genotoxicity testing). Analysis of the comet images showed that the presenting rate of ‘comet’ as well as the tail moments of the buccal cells’ DNA from people living in apartments decorated within a year were obviously higher (P < 0.01) than in those from people who lived in the apartments decorated several years ago, which lends strong support to our conclusion that people living in newly-decorated apartments are much more liable to be harmed by the formaldehyde released from their indoor decoration. In addition, high-quality decoration material tends to be less harmful to people.

5.2.2 Indoor environment, asthma, allergies, sick building syndrome (SBS) in the Swedish population – a longitudinal cohort study from 1989–1997

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Changes of asthma, allergies, SBS and indoor exposures in the dwelling were studied in an 8-year follow-up study of a random sample of the population (N = 466) in a 3-county region in Sweden, initially aged 20–65 y. In total, 348 (75%) answered the postal follow-up questionnaire. Some improvements of the home environment were observed. Water-leakage during the last year had decreased from 11.2% to 4.8% (p = 0.005), visible indoor mould had decreased from 4.7% to 1.6% (p = 0.02), and any sign of building dampness decreased from 16.1% to 9.5% (p = 0.004). Dwellings with mechanical ventilation either in living rooms or bedrooms increased from 11.8% to 16.4% (p = 0.014). The cumulative incidence of asthma had numerically increased from 5.2% to 7.2% (0.25%/y) (p = 0.09), while the prevalence of hay fever (14%) and any types of allergy (25%) remained unchanged. A few SBS-symptoms had decreased, e.g nasal catarrh (15% to 4.7%) (p = 0.003), sensation of getting a cold (25% to 15%) (p = 0.002) and there was a numerical decrease of sore throat (9% to 6%) (p = 0.06). Moreover, the prevalence of current smoking had decreased from 30% to 19% (p < 0.001). In conclusion, our data suggests that the number of damp buildings has decreased in Sweden, possible due to better maintenance and other improvements, and ventilation have improved. Moreover, tobacco smoking and some respiratory SBS-symptom decreased during the follow-up period, suggesting improved health conditions.

5.2.3 Environmental interventions to reduce allergen exposures

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Environmental exposures to allergens and irritants may cause or exacerbate asthma, and controlling these exposures is an important component in managing asthma. The Minnesota Department of Health, in cooperation with Pediatric Home Service, is conducting a demonstration project to reduce the environmental triggers in homes of children with asthma. A certified Asthma Educator/respiratory therapist provides in-home asthma education along with low cost environmental interventions. Prior to the intervention, information is collected regarding the number of emergency department visits, hospitalizations, missed school days, and unscheduled clinic visits that occurred in the previous 3 months. After the intervention has occurred, this same information is collected at intervals of 3 months (telephone interview), 6 months (home visit), 9 months (telephone interview), and 12 months (home visit). The data are being analyzed to determine the success of the intervention in reducing morbidity and the sustainability of the intervention.

5.2.4 A modified protocol of comet assay on human buccal cell

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In order to improve the efficiency of comet assay, which can be used in epidemiological research to detect genotoxicity of air pollutants, we undertook this study. Formaldehyde at 50 μM was employed as contaminating agent to poison the human buccal cell before comet assay. During the process of comet assay, each pair of contaminated samples was treated with proteinase K of three different concentrations at 0.1 mg/ml, 1 mg/ml and 10 mg/ml, respectively while other steps are kept the same. The result turned out to be that the 1 mg/ml proteinase K could lead to an ideal incubating effect. It was also proved that a 45-minute lysis had almost the same effect as the 120-min one. A further try was the reduction of the enzyme-incubation period to 45 min; the result showed that with the treatment of 1 mg/ml proteinase K, a 45-minute lysis and a 45-minute enzyme-incubation as well can achieve a relatively ideal result.

5.2.5 Longitudinal effect of interventions and other determinants on cockroach allergen levels in public housing

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Public housing like other low-income, urban housing is plagued with cockroach infestation. One concern with infestation is that cockroach allergens have been associated with asthma exacerbation and morbidity.
ity, particularly among inner-city children. Interventions to reduce allergen levels have been implemented with variable success. The study presented here is part of the Boston Healthy Public Housing Initiative. The objective is to evaluate the long-term effectiveness of intervention efforts in public housing. Interventions, including intensive cleaning, integrated pest management, resident education, mattress replacement and provision of air cleaners, were conducted in apartments of 58 asthmatic children (ages 4–17) in three developments. Bed and kitchen dust were analyzed by ELISA for cockroach allergens, Bla g 1 and 2. Samples for repeated measurements were collected: once at baseline and two or three times after interventions. Longitudinal analysis was performed using a mixed model to address the issue of unbalanced repeated measures. Baseline geometric means in units per gram of dust for Bla g 1 and 2, respectively, were 21.66 and 57.23 in the kitchen and 0.50 and 2.19 in the bed. Kitchen Bla g 1 showed no significant change with time after intervention; however, kitchen Bla g 2 had decreased significantly by 60% at 19 weeks, then increased to 25% below baseline at 39 weeks. Bed Bla g 1 levels decreased significantly by 43% then rose to 37% below baseline by week 39. Bed Bla g 2 levels fell 25% until 21 weeks after intervention and rose to 5.2% below baseline by week 39. Units rated by visual inspection as below average in housekeeping quality had significantly higher cockroach allergen concentrations. These findings indicate that intensive interventions in the indoor environment can yield significant reductions in cockroach allergen levels. However, reductions may not be sustainable without continued implementation of integrated pest management measures. Behavior modification and improvements to physical conditions must be part of the intervention strategy.

5.2-6 Day care attendance and increased risk for air way infections and allergic symptoms. DBH phase I
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Numerous studies have shown that day care attendance is related to increased prevalence of airborne infections, otitis media and other symptoms associated with infections among small children. Some studies have found that day care attendance during the first year of life is protective against asthma and allergy, especially among children with few siblings. These reports have been interpreted as a support for the hygiene hypothesis, proposing that the increase in allergies in affluent societies is due to less microbial exposure (a too clean environment). Consequently, more exposure to microbes and more infections, particularly in early life, should protect against allergy and asthma.

A cross sectional questionnaire study was performed in the year 2000 in Sweden as a first step of the Dampness in Buildings and Health (DBH) study. Data on 10 851 children (1–6 year) corresponding to a cross sectional questionnaire study on day care attendance during the first year of life is protective against asthma and allergy, especially among children with few siblings. The analyses were performed using a mixed model to address the issue of unbalanced repeated measures. Baseline geometric means in units per gram of dust for Bla g 1 and 2, respectively, were 21.66 and 57.23 in the kitchen and 0.50 and 2.19 in the bed. Kitchen Bla g 1 showed no significant change with time after intervention; however, kitchen Bla g 2 had decreased significantly by 60% at 19 weeks, then increased to 25% below baseline at 39 weeks. Bed Bla g 1 levels decreased significantly by 43% then rose to 37% below baseline by week 39. Bed Bla g 2 levels fell 25% until 21 weeks after intervention and rose to 5.2% below baseline by week 39. Units rated by visual inspection as below average in housekeeping quality had significantly higher cockroach allergen concentrations. These findings indicate that intensive interventions in the indoor environment can yield significant reductions in cockroach allergen levels. However, reductions may not be sustainable without continued implementation of integrated pest management measures. Behavior modification and improvements to physical conditions must be part of the intervention strategy.

5.2-7 Microbial exposure indoor and its association to asthma and allergy among children in Sweden, DBH-phase II
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With the aim to identify health relevant exposures in buildings an epidemiological study ‘Dampness in Buildings and Health’ (DBH) started in the year 2000 in Sweden. The health focus of the study is on asthma and allergic symptoms among small children and their parents. The first step of the study was an epidemiological cross-sectional questionnaire study on housing and health on 10 852 pre-school children in the county of Värmland in Sweden, (March–April 2000). The second step of the study was a case control study nested (198 cases and 202 controls) within the cohort of 10 852 children. A detailed clinical examination by physicians in parallel with extensive inspections and measurements of microbiological and chemical exposures indoor in the subjects’ homes were conducted during October 2001–April 2002. The aim with the current study was to examine associations between microbial exposure in indoor dust and asthma/allergy among children. Samples of dust from the cases and controls homes (n = 390) were collected from the floor in the living room and analysed for the content of viable mould spores. Analyses of potential associations between concentrations of mould spores in dust and health have been conducted using non-parametric tests (Mann–Whitney U). Log-transformed, normally distributed concentrations were tested with parametric tests (T-test) and multiple logistic regression. The analyses were considered to be statistically significant when p < 0.05. The concentrations are reported as medians, and as geometric means with 95% confidence intervals (CI). The confidence intervals were calculated with a back-transform of mean log ±2*standard error of mean log (SE). The geometric mean for the total mould load was 38.9 CFU (95% CI: 35.5–42.7). In total, 66 different mould spores were identified in a concentration range of 0–302 CFU. However, only 16 of these were identified in more than 10% of the homes. The prevalence of selected moulds in the 390 dust samples...
were: *Alternaria tenuis* gsp (60%), *Aspergillus versicolor* (9%), *Cladosporium sphaerospermum* (4%), *Penicillium chrysogenum* (2%), *Penicillium* (Total) (85%), *Phoma sp.* (13%), *Stachybotrys chartarum* (3%), *Trichoderma viride* and *harzianum* (35%), *Ulocladium ode-mansii* (24%) and Yeasts (52%). Cases had a higher median concentration of *Penicillium* compared with controls (11 vs. 8 cfu, Mann Whitney U: p = 0.031). Further, the geometric mean for *Penicillium* was higher for cases compared with controls [12.8 cfu (95% CI: 11.0–12.8) vs. 10.7 cfu (95% CI: 9.1–12.3)], however not significant (t-test: p = 0.09). Finally, a dose-response relationship was indicated in a crude logistic regression when the concentration of *Penicillium* was divided into quartiles (1st quartile (REF), 2nd quartile OR 1.29 [95% CI: 0.74–2.26], 3rd quartile OR 1.58 (0.91–2.75), 4th quartile 1.89 (1.08–3.31)). The same indication of a dose-response relationship was found when adjustments were made for potential confounders. Regarding other mould spores no significant associations were found.

### 5.2.8 Building characteristics and observed dampness problems and associations to asthma and allergy among 400 Swedish pre-school children

**DBH Phase II**

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In a multitude of studies, associations between moisture problems and asthmatic and allergic symptoms have been found. Most field-studies have used questionnaires but some have also used professional inspectors to detect mould problems in dwellings. A nested case control study with 198 children with asthmatic and allergic symptoms (cases) and 202 healthy controls was performed between October 2001 to April 2002 in Värmland in Sweden. Professional inspectors made inspections and measurements in the subjects’ homes and physicians made a detailed clinical examination of the children. No destroying methods or uncovering of constructions was used to detect mould problems. Observations on visible signs of moisture problem and perceptions of odour were categorized depending on estimated grade of severity; no remarks, possible remarks or obvious remark. Statistical analyses were performed in Statistical Package of Social Science, SPSS. Adjusted Odds ratios (AOR) were estimated in logistic regression models and adjustments were made for sex, age, allergic symptoms in the family, smoking among parents, type of building and construction period of the building. Trend analyses for assessment of a dose response association were estimated by Linear by Linear Regression analysis. The inspectors found visible mould spots on indoor surfaces in the children’s bedroom in only four houses (1.0%), all with natural ventilation. Damp stains were more frequently observed (11.3%) and more common in older houses (p = 0.002). Indications of a moisture problem in the floor (blackened parquet or PVC-flooring with bubbles) were observed in 3.0% of the buildings and more often in houses from the sixties and seventies however the difference as not significant. A mouldy odour was significant more often detected in houses from the seventies (31.1%) compared with older buildings (17.8%, p = 0.010) and newer buildings (9.3%, p = 0.002). Visible mould, indications of a moisture problem in the floor and a general mouldy odour in the rooms were somewhat more frequently observed in the homes of the cases (1.5%, 4.0% and 20.7%) compared to controls (0.5%, 2.0% and 20.7%), but the difference was not significant. However, the inspectors’ report of a mouldy odour along the skirting board was associated with case status compared with controls [AOR 1.66 (95% CI: 1.01–2.74)], with asthma [AOR 1.39 (95% CI: 0.79–2.46)], with rhinitis [AOR 2.32 (95% CI: 1.26–4.26)], and with eczema compared with controls [AOR 1.88 (95% CI: 1.07–3.32)]. There was also a significant dose response relationship between a higher severity of mouldy odour along the skirting board and case status (p = 0.013), rhinitis (p = 0.002) and eczema (p = 0.003) and near significance for asthma (p = 0.054). An inverse dose response association were found between observations of damppdiscoloured stains and eczema (p = 0.022). In Swedish houses, visible mould is rarely seen on surfaces in bedrooms, as the buildings are well insulated, and the relative humidity in indoor air is often quite low (15–30% relative humidity during the winter season). A mouldy smell especially near junctions as along the skirting board is, however, often a good indicator of hidden microbiological activity in the wall or floor construction. Visible signs of moisture problem appear not to be a health relevant sign of dampness as it is in many other studies in other climates. The results show that an inspection should be focused on detecting moisture damage inside of the construction, at least in Scandinavia.

### 5.2.9 Housing characteristics and health in Sweden and Bulgaria: two questionnaire studies

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Two multidisciplinary cross-sectional studies on housing and health were held in Sweden (2000) and Bulgaria (2004), using the same questionnaire. Questionnaires were distributed to 14,077 parents of preschool children in the county of Värmland (Sweden) and 12,816 in Sofia and Bourgas (Bulgaria). In more than 80 questions, information on respiratory health, home exposure and personal habits were collected. 10,851 Swedish children and 6,156 Bulgarian children comprised the final study cohorts. 31.9% of parents in Bulgaria and 1.6% in Sweden reported visible mold or damp spots in the child’s or parents’ bedroom. For 32.6% of the Bulgarian and 9.4% of the Swedish homes moisture problems in the floor existed. Reports of condensation on windowpanes were equally common in the two countries (14.3%, resp. 14.2%). The prevalence of wheezing (28.2%) and rhinitis (28.2%) was higher in Bulgaria than in Sweden (16.2%, 11.1%). The opposite was valid for ‘ever eczema’ (Bulgaria – 18.4%, Sweden – 23.1%). The prevalence of ‘asthma’ diagnosed by a doctor (4.9% – Bulgaria and 5.4% – Sweden) was similar in the two countries, but doctor diagnosed ‘hay fever’ or ‘allergic rhinitis’ was more common in Bulgaria (8.2% vs. 2.2% in Sweden). Crude odds ratios for symptoms and the different reported dampness problems were about the same in the two studies (OR 1.41–1.81). In both studies, a consistent association was found between dampness characteristics indoor and the asthma and allergic symptoms among children and their parents.
5.2-10 The home environment and allergies among Bulgarian children

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To explore the role of home exposures on allergies and asthma among children, the ALLHOME project was initiated in Bulgaria. Parents of 6155 out of 12982 children (2–7 years old, girls/boys: 47.6%/52.4%), obtained from the National register, participated in a cross-sectional study, performed in 2004. Two towns were included in the survey: the seacoast town of Bourgas and inland town of Sofia. All children were born in any of the two towns and their parents participated in the study by filling out questionnaires sent to them by post or attending a phone call survey or filling out the web version of the questionnaire. Data on the index child’s and family’s health, residence, water leakages, flooding, condensation, visible mould, smoking, food, pet keeping, TV and PC use, were collected in 88 questions. The questions were identical to those used in the study ‘Dampness in Buildings and Health’ (2000), performed in Sweden, except for few questions, adapted or changed due to the country’s specificity. Twenty eight percent of the parents reported wheezing or whistling in the chest of their children, 28.2% – rhinitis (both in the last 12 months) and 18.4% eczema – ‘ever in the past’. 4.9% of the children were reported to have a doctor-diagnosed ‘asthma’ and 8.2% – a doctor-diagnosed ‘hay fever’ or ‘allergic rhinitis’. Cough at night in the last 12 months were reported for 11.4% of the children, rhinitis on pet exposure – for 4.5%, and rhinitis on pollen exposure – for 12.1%. Significantly more children on the seacoast (Bourgas) suffered from wheezing (31.5%) or rhinitis (29.8%) in the last 12 months compared to children from the inland city (Sofia, 25.4% and 26.7%). Almost no regional differences were observed for ‘eczema-ever’, doctor diagnosed ‘asthma’, and ‘hay fever’. Living in Bourgas compared to Sofia was a risk factor for the children for wheezing (aOR 1.3, CI 95% 1.1–1.5), rhinitis (aOR 1.3, CI 95% 1.1–1.4) and doctor-diagnosed asthma (aOR 1.4, CI 95% 1.1–1.8). In contrast, living in Sofia was a risk factor for eczema-ever (aOR 1.2, CI 95% 1.1–1.4). In the analyses adjustments have been made for potential confounders sex, age, current parents’ smoking, type of building, type of questionnaire, place, mother or father or siblings with asthmatic or allergic problems, 25.8% of the parents in Sofia and 21.3% – ‘ever’ in Bourgas reported to have at least one symptom of asthma, rhinitis and eczema. Mother or father with atopic or allergic problems was a risk factor for their children to have any of the symptoms: wheezing (aOR 1.6, CI 95% 1.4–1.9), rhinitis (aOR 1.8, CI 95% 1.5–2.0), eczema-ever (aOR 1.8, CI 95% 1.6–2.1), doctor-diagnosed asthma (aOR 2.1, CI 95% 1.7–2.7) and doctor-diagnosed hay fever (aOR 2.5, CI 95% 2.0–3.0). 83.9% (Bourgas – 81.4%, Sofia – 86.2%) of the families involved in the study were living in multi-family houses (MH) and 12.8% (Bourgas – 16.5%, Sofia – 9.6%) – in single-family houses (SH). 3.2% reported for living in other type, different from single/multi-family houses. Regarding type of construction – 23.8% (Bourgas – 29.3%, Sofia – 19.1%) of the multi-family houses were made of brick and 60.1% (Bourgas – 52.1%, Sofia – 67.1%) – of concrete-panels. 83.3% of the buildings were built between 1961 and 2000. The families owned 79% of the buildings. Living in a single-family house compared with in multi-family houses was associated with children wheezing in the last 12 months (aOR 1.5, CI 95% 1.2–1.7), and eczema-ever (aOR 1.2, CI 95% 1.0–1.5). However, no significant association was found to other symptoms. Children living in buildings erected before 1945 compared with buildings constructed after that period were significantly associated with doctor-diagnosed asthma (aOR 2.1, CI 95% 1.3–3.3). The ‘child’s room’ was defined as the room in which the child spend most of his/her time, especially during the night. A majority of the children (63%) were sleeping with the parents, 17.9% were sleeping in own rooms, 17.1% – shared bedrooms with siblings and 2.1% – in different rooms. ‘Balatum’ (a public name for either linoleum or PVC flooring) was a commonly reported floor material in the child’s room (31.9% of all homes, Bourgas – 49.0% and Sofia – 17.8%). Such flooring material was used in the child’s rooms in 31.1% of the single-family houses and 32.6% of the multifamily-houses. In general ‘balatum’ was present as flooring material either in the child’s, parents’ rooms or kitchens in 52.8% of the buildings (44.1% – SH, 54.4% – MH). In 31.6% of the houses, wooden parquet or wooden floorboards covered the child’s floors (37.1% – any room: child’s, parents’ room or kitchen) and in 20.8% (27.2% – any room) – wall-to-wall carpet. Laminated parquet (8.6%) and tiles (5.1%) was also chosen as floor materials in some of the child’s rooms. ‘Balatum’ as a floor covering was significantly associated with doctor-diagnosed ‘asthma’ among children (aOR 1.5, CI 95% 1.2–2.0). Regarding heating system, other type than hot-water radiators (41.4% of all homes) increased the risk for at least two symptoms (wheezing, rhinitis or eczema-ever) among children (aOR 1.4, CI 95% 1.2–1.6). Being without a kitchen fan for ventilation (68.4% of all homes) was a risk factor for doctor-diagnosed asthma (aOR 1.6, CI 95% 1.2–2.1), compared with living in a home with a kitchen fan (29.4% of all homes). Using wood as fuel in fireplace, stove or boiler was a risk factor for rhinitis (aOR 1.3, CI 95% 1.1–1.5). Damp stains on the floor, walls or ceiling in the child’s room were detected in 16.1% of all the houses (17.6% – SH, 15.8% – MH). Significantly more often damp stains were reported for the child’s room in Bourgas (18.4%) than in Sofia (14.3%). Parents reported in 18.3% of the houses (18.1% – SH, 17.9% – MH, 20.2% – Bourgas, 16.6% – Sofia) for mould on the floor, walls or ceiling in the child’s room. In 22.0% of the dwellings (25.6% – Bourgas, 18.9% – Sofia) moisture or mould problems were suspected in the construction. Condensation on the inner side of the windowpane were reported for 22.0% of the child’s rooms and condensation more than 5 cm in 14.2% of them (Bourgas – 14.5%, Sofia – 14.1%). Water damages in the child’s room were significantly more often observed in Sofia (ever – 8.2%, last year – 2.4%) than in Bourgas (ever – 5.9, last year – 1.4%). A trend of more water damages in multi-family houses (ever – 7.4%, last year – 2.1%) than in single-family houses (ever – 5.7%, last year – 1.7%) was also observed. Visible mould observed in the child’s room was associated with several symptoms: wheezing (aOR 1.5, CI 95% 1.3–1.8), rhinitis (aOR 1.4, CI 95% 1.2–1.6) and eczema-ever (aOR 1.4, CI 95% 1.1–1.6). The same was valid for visible damp stains on floor, walls or ceiling and wheezing (aOR 1.6, CI 95% 1.4–1.9), rhinitis (aOR 1.6, CI 95% 1.4–1.9), eczema-ever (aOR 1.3, CI 95% 1.1–1.6) and doctor-diagnosed asthma (aOR 1.5, CI 95% 1.0–2.0). Any condensation on the windowpane in the child’s room was associated with wheezing (aOR 1.3, CI 95% 1.2–1.5), rhinitis (aOR 1.4, CI 95% 1.1–1.7) and doctor-diagnosed hay fever (aOR 1.3, CI 95% 1.2–1.5). Detached or discolored ‘balatum’ or wall-to-wall carpet in the child’s rooms was associated to wheezing (aOR 1.7, CI 95% 1.3–2.2), rhinitis (aOR 2.1, CI 95% 1.6–2.7), eczema-ever (aOR 1.4, CI 95% 1.1–1.9) and doctor-diagnosed hay fever (aOR 1.7, CI 95% 1.1–2.4).

The study adds to the evidence that selected indoor factors are associated with asthma and allergies among children. Single-family houses, buildings built before 1945, ‘balatum’ as flooring material, excess moisture, condensation, water leakage and detached/discolored floor were associated with an increased risk of allergic and asthmatic symptoms among children.
5.2-11 Indoor exposures and risk of asthma and allergy: a systematic and critical review.

Preliminary report

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Systematic and critical review of published reports is needed to assess the level of evidence for causal relationships between indoor exposures and asthma and allergy, including the effects from interventions. We performed a systematic critical review of papers describing both relevant indoor exposures and relevant health outcomes. Searches in Medline and Embase from 1966–2003 yielded close to 12,000 publications. 2175 potentially relevant abstracts were reviewed, 1080 publications were subjected to full text assessment, and after selection by study design and other quality criteria 362 publications were included in a final assessment. Qualitative and quantitative analyses were performed within the areas of allergen, environmental tobacco smoke, dampness, and other exposures. The findings so far indicate health effects from dampness and environmental tobacco smoke. Measures to reduce mite allergen exposure of new-born high risk children did not appear to reduce sensitization, whereas some effect was found for asthma.

5.2-12 Ventilation and dampness in Danish homes with asthmatic and non-asthmatic children

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The home air constitutes a dominant exposure to a child, and may be important for the development of asthma and allergies. In Denmark and Bulgaria multidisciplinary studies are planned, investigating associations between home environment and the development of asthma and allergy during childhood. To test methods and materials for these and other similar projects a pilot project on 20 children with asthma and 20 without was initiated in Denmark. The main objective of the study was to test new methods for measuring ventilation rates in homes and exposure to phthalates. A new low-cost method for measuring ventilation was tested, along with new methods to measure phthalates in floor materials, toys, etc. During the visit in the children’s homes a questionnaire was handed out and a thorough inspection of the residence was performed. Air temperature, RH and CO₂ for a 48-hours period were measured and dust and PVC samples were collected. The questionnaire concerned general background information of the child and the family; data regarding the child’s and the family’s health and questions on the residence of the child were collected. A pre-established checklist regarding e.g. building characteristics, mould, water damages and surface materials was followed. The results of the pilot project will be presented.

5.2-13 The effectiveness of combined washer-dryers in removing panese cedar pollens for clothing dried outside

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During the pollen dispersal season, large volumes of pollens adhere to clothing dried outside. Studies indicate that as much as 40% of adhered pollens remain on clothing after shaking (1). In this study, the ability of washer-dryers to remove Japanese cedar pollens from clothing dried outside was examined. Pollens were collected from clothing using a membrane filter and their allergenic qualities were determined quantitatively. Using a combined blowing and agitating process that lasts 15 minutes, the study shows it is possible to remove over 90% of pollen allergens from clothing dried outside.

1. H Kiyosawa, S Yoshizawa. Quantitative determination of pollen blown indoors and study on the prevention of indoor air contamination by pollens. Journal of Architecture, Planning and Environmental Engineering, 2002, 558, pp. 37–42.

5.2-14 Environmental health study of Swedish children

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Background: The aim of this prospective and longitudinal project is to establish crucial risk factors for asthma and other allergic diseases in childhood. This part of the study investigates the relationship between the indoor environment and atopic disease in children at the age of four years. Material and methods: The cohort comprises 4089 infants born from 1994 to 1996 in central and north western parts of the Stockholm, Sweden. A first questionnaire was administered when the children were 2–3 months of age and focused on allergic heredity and environmental exposures. Both at one, two and four year’s age parents answered questionnaires on symptoms of allergic diseases. At four years, the children were also invited to a clinical examination including blood sampling. In order to define sensitisation, all sera were screened with Phadiatope®, a mixture of common inhalant allergens (Pharmacia CAP System®). Risk associations were calculated with a multiple regression model, with adjustment for potential confounders. Results: At 4 years of age, early exposure to indoor mould and dampness increased the risk of asthma, OR 1.4 (CI 1.1–1.9). Both early onset transient asthma (asthma at 2 but not 4 years: N = 186) and early persistent asthma (at 2 and 4 years: N = 117) were found more common among children living in homes with various signs of dampness and mould, OR 1.8 (1.1–2.9) and OR 2.0 (1.1–3.8), respectively. The association was strengthened for children still living in the same home as when they were new born. However, signs of dampness were not associated with an increased risk of sensitisation to common inhalant allergens.

Conclusion: Early exposure to various indicators of dampness and
mould in the home seems to increase the risk of childhood asthma at 4 years of age. However, asthma related to exposure to dampness was not associated with an increased risk of risk of sensitisation to inhalant allergens.

5.2-15 A pilot investigation on human serum formaldehyde-specific IgE
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Sensitizing potency of air formaldehyde during 4 weeks of an anatomy dissection course was investigated in 8 medical students. Serum formaldehyde-specific IgE antibodies by ELISA were assessed after the course. At beginning and ending of the course, primarily irritant and systemic symptoms experienced during the dissection lessons were noted. Indoor formaldehyde levels were measured continuously. The mean indoor formaldehyde level was 0.598 ± 0.088 ppm. Serum formaldehyde-specific IgE antibodies were found in none of the students after the course. Assessment of symptoms during the lesson revealed significant increase tendency: fatigue in 7/8 students (p < 0.001), headache in 6/8 students (p < 0.001), sneezing in 5/8 students (p < 0.001), burning eyes in 4/8 students (p < 0.003), paraesthesia in 4/8 students (p < 0.005), and cough in 3/8 students (p < 0.028). According to our investigated data, 4 weeks exposure to formaldehyde during an anatomy dissection course does not induce formaldehyde-specific IgE.

5.2-16 Determinants of moisture damage and asthma in Finnish residences
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Excess moisture in buildings may cause damage and consequent increased exposure to indoor air pollutants, and it has been associated with increased prevalence of respiratory disorders among children occupying the buildings. This study was conducted in order to find out specific associations between asthma case-control status of children and moisture damage and building/housing characteristics of the homes of these children. The hypothesis was that certain building/housing characteristics increase the risk for moisture damage, which increases risk for asthma. Modeling moisture damage as a function of these characteristics may therefore provide a simple tool to estimate building related risk for asthma. The health data consisted of information on 121 asthmatic children and predominantly two age and gender matched control children for each case. The building data consisted of information on building characteristics, environmental conditions on site, and occurrence and characteristics of moisture damage in the homes of the children. In our previous analyses, we associated moisture damage observations in main living areas with increased risk for asthma. None of the building characteristics as such associated with increased risk for asthma. Using step-wise logistic regression, five models were formed to predict 1) overall moisture damage status in the homes and 2) moisture damage status of living areas. Using the models, we were able to classify the damage status of the homes correctly in 65.0–87.7% of the cases (kappa-values 0.10–0.47) as functions of building/housing characteristics. None of the models qualified as a significant determinant of the case-control status of the children using conditional logistic regression. In conclusion, it was not possible to estimate building related risk for asthma by studying the building/housing characteristics only, but detailed information on the damage (such as location of damage) was crucial for such estimation.

5.2-17 Risk factors for allergic asthma in a case-control study of adults
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Objective To investigate the risk factors of adults’ allergic asthma or its onset, especially the indoor environmental risk factors.

Methods The case-control study used to collect the information from 102 cases of adults’ allergic asthma and 394 controls. The information included general social demographic characteristics, disease history, smoking history, the history of occupation, indoor environmental situation and family’s genetic history.

Results The case group had the higher proportion of occupational dust exposure history than the control group (P < 0.05, OR = 1.78) and also had the statistical significance. The poorer house conditions was more likely to cause adults’ allergic asthma or its onset, the odds ratio were 3.24. The results also showed that there was a relationship between the frequency of quilts’ solarization and adults’ allergic asthma (P < 0.10, OR = 1.53). And we also found that the frequency of using wood floor in the living room in the cases was higher than that in the controls (P < 0.01, OR = 2.33) and the same result of the indoor cooking-oil fume contamination degree (P < 0.01, OR = 2.52). The statistical significant correlation was also found between the adults’ allergic asthma and their parents asthma or chronic bronchitis history (P < 0.01, OR = 2.32).

Conclusions The study showed that in the indoor environmental risk factors, poor house condition, the fewer frequency of solarization for quilts, using wood floor in the living room as well as indoor cooking-oil fume contamination were the possible risk factors of the adults’ allergic asthma. Occupational dust exposure and the family genetic history were also the possible risk factors of the adults’ allergic asthma. The study indicated that adults’ allergic asthma was a multi-factorial complex disease and the interaction of environmental and genetic risk factors played an important role in the onset of this disease.

5.2-18 The relationship between the indoor air formaldehyde exposure and allergic asthma in adults – a case-control study
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Objective To investigate whether there is a relationship between the indoor air formaldehyde exposure and allergic asthma in adults.

Methods The case-control study method was used to collect the information of the 30 cases and 91 controls. All 111 subjects’ indoor air samples were collected and assayed for the concentrations of formaldehyde by standard methods.

Results The concentration of the indoor air formaldehyde was higher in cases than that in controls and the difference had statistical significance (P < 0.0001). After ranking the concentration of formaldehyde into 4 quarters, comparing with the first quarter, the other 3 quarters’ unadjusted OR values were increasing respectively; and after adjusting for age, gender, present smoking and family chronic bronchitis or asthma history, the OR values were increasing also. Meanwhile, the total trend OR value showed that the risk of the adults’ allergic asthma would be increased 2.51 times (unadjusted) and 2.36 times (adjusted) with each quarter increasing of the indoor air formaldehyde concentration. Furthermore, the risk of the adults’ allergic asthma would be increased 0.02 times than before when the indoor air formaldehyde concentration increasing each 1 µg/m³. Simultaneously, the study also indicated that decoration could increase the indoor air formaldehyde concentration 30.65 µg/m³ averagely.

Conclusions There is a definite dose-response relationship between the adults’ allergic asthma and indoor air formaldehyde exposure. But the obvious risk will be showed up only when the concentration of the indoor air formaldehyde reaches to a certain high lever.
5.3 Cancer and reproductive effects

5.3-1 Monitoring of genotoxicity of formaldehyde on human buccal cells with comet assay

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Purpose: Whether formaldehyde induces DNA breakage or not is still in debate. So far it is not clear whether dose-effect between formaldehyde and DNA breakage takes place while the DPC exists. Approach: In this study we had chosen human buccal cells as materials to explore the genotoxicity of liquid and gaseous formaldehyde with comet assay. Findings: The results showed that liquid formaldehyde induced DNA breakage in the range from 5μM to 10μM (P < 0.05, compared with control group), and 7.5μM was found to induce DNA breakage most. The DNA crosslinks were significantly found at 15μM, 30μM and 50μM (P < 0.01, compared with 7.5μM group). DNA breakage caused by gaseous formaldehyde was found at 0.5 mg/m3 and 1.0 mg/m3 (P < 0.01, compared with control group) but DNA crosslinks at 3.0 mg/m3 significantly. Conclusions: The results suggest that formaldehyde induces DNA breakage in a very low concentration range but induces DNA crosslinks in a higher range.

5.3-2 The effect of formaldehyde on the proliferation of cultured cells

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Numerous studies have shown that formaldehyde is genotoxic and mutagenic to mammalian cells. It can induce a broad spectrum of genetic effects, such as DNA cleavage and DNA-protein crosslink. In addition, endogenous formaldehyde, generated from biochemical pathways, is a kind of normal intermediary metabolites in biological systems. Studies of animals and humans have shown that formaldehyde undergoes rapid biotransformation immediately after absorption to formate, which is partially incorporated via normal metabolic pathways into the one-carbon pool of the body, or further oxidized to carbon dioxide. Therefore, no increase in its concentration in tissue or blood can be detected even after exposure to formaldehyde. To investigate the direct effect of formaldehyde on the proliferation of cells, formaldehyde was applied with various doses (0–80μmol/ml) into the hepatoma cell lines SMMC 7721 and L-02 cell lines in vitro. MTT assay was performed to prove whether low doses of formaldehyde could enhance cell proliferation, whereas high doses reduce as we have hypothesized according to many past studies in this field. Especially, a predominant accelerating effect was found by the effect of 50 μmol/ml of formaldehyde on L-02 cells and 70μmol/ml on SMMC-7721 cells respectively. This result suggests that the genotoxicity of formaldehyde may not be its direct damage on organisms. Therefore we can conclude that formaldehyde may play an important role as an endogenous signal factor in adjusting the cell proliferation.

5.3-3 Air formaldehyde exposure and DPC in buccal cells of undergraduate students

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Objective To study the effect of formaldehyde on DNA–protein crosslinks (DPC) in buccal cells in students who were taking anatomy course.

Methods The modified KCl-SDS precipitation assay was applied. This method has been used to explore DPC induced by different pollutants in laboratory studies.

Results 37 students in medical school and 40 in school of sciences were studied. The frequency of exposure to formaldehyde was 6h per week in exposed group. Concentrations of formaldehyde in anatomy laboratory ranged from 0.42 to 1.57 mg/m3. Exposure to formaldehyde resulted in an increase of DNA-protein crosslinks. DNA-protein crosslinks in exposed and nonexposed students were 25.72 ± 6.48% and 22.88 ± 5.34% (p < 0.05), respectively. Air formaldehyde caused a significant increase in DNA–protein crosslinks of the females in two groups (27.72 ± 5.76% and 22.29 ± 4.20%, p < 0.01). However, there was no difference in males (24.02 ± 6.72 and 23.48 ± 6.33, p > 0.05).

Conclusions The results suggest that exposure to formaldehyde in medical students increase the frequency of DNA–protein crosslinks in buccal cells. Our results also indicate that females may be more sensitive to formaldehyde exposure.

5.3-4 Effects of formaldehyde on proliferation in cell lines

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Purpose Numerous studies have confirmed that formaldehyde is genotoxic and mutagenic to mammalian cells. It can induce a broad spectrum of genetic effects. In order to investigate the direct effect of formaldehyde on the proliferation of cells, we undertook this study.

Approach The L-02 and hepatoma SSMC 7721 cell lines were exposed to various concentrations of formaldehyde in vitro. MTT assay was used to evaluate the effects of formaldehyde on the proliferation.

Finding The results showed that the cells’ proliferation was enhanced after being treated with low dosages of formaldehyde. However, it was decreased after exposure to high dosages of formaldehyde. A predominant accelerating effect was found at the concentrations of 50μg/ml in L-02 cells and 10μg/ml in SMMC-7721 cells, respectively.

Conclusions The results suggested that different kinds of cells had different formaldehyde equilibrium system. The cells would present different reactions at the same dosages of endogenous or exogenous formaldehyde.

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5.3.5 Influence of air formaldehyde from indoor decoration on buccal cells of the residents in Wuhan city

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Formaldehyde released from a variety of indoor decorating materials including plywood used in furniture making and floor covering as well as adhesives and coating agents used in wall decoration, is believed to be one of the resources of indoor air pollution that harm people’s health most seriously. In this study, 60 families in a same community are investigated. Among these families, 30 were decorated within one year while the corresponding ones decorated at least 4 years ago. Buccal cells donated by people available in these families are employed to carry out single cell gel electrophoresis (SCGE, Comet assay), which provide direct evidence for the genotoxicity caused by formaldehyde in these people. Influence factors including age, gender, quality of the decoration materials, living habits, decorating situations in working place and some other factors that might affect the result are also taken into account. Analysis of the comet images shows that the presenting rate of ‘comet’ as well as the tail moments of the buccal cells DNA from people living in apartments decorated within a year are obviously higher (P < 0.05) than in those from people who live in apartments decorated several years ago, which lends strong support to our conclusion that people living in newly-decorated apartments are much more liable to be harmed by the formaldehyde released from their indoor decoration. In addition, high-quality decoration material tends to be less harmful to people. To respond to this result, we suggest that people planning to move house should not be anxious to live in a newly-decorated apartment until at least the formaldehyde concentration of the indoor air is detected to be below 0.08 mg/m³, as the national standard prescribes. Besides, high-quality materials should be employed rather than the bad ones in indoor decoration and ventilation is a habit beneficial to the health.
5.4 Chronic respiratory diseases

5.4-1 Respiratory conditions are associated with household factors in middle age men in Wuhan, China

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We examined associations between respiratory conditions and multiple household factors among 2360 middle age men (mean = 38.4 yrs old) from Wuhan, China. Factor analyses reduced seventeen original household variables to five new uncorrelated factor variables: heating coal smoke, cooking coal smoke, ventilation, socio-economic status, and any home cigarette smoker. Unconditional logistic regression models examined associations between the factor variables and the respiratory outcomes. We found that heating coal smoke exposure was associated with persistent cough, persistent phlegm, and wheeze. Cooking coal smoke was associated with asthma. Household ventilation was not associated with any health outcomes. Lower socio-economic status was associated with lower reporting of bronchitis. Any home cigarette smoker was associated with higher reporting of persistent cough, persistent phlegm, cough with phlegm, and bronchitis. Our study suggests that there are independent effects of exposure to heating coal smoke, cooking coal smoke, and any home cigarette smoker for the studied men.

5.4-2 Lung function is associated with cooking coal smoke among primary school children in Wuhan, China

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We examined associations between lung function and multiple household risk factors among 463 primary school children from Wuhan China. We used factor analysis to develop new uncorrelated ‘factor’ variables. We used linear regression models to examine associations between the factor variables and lung function parameters. Three factors were derived from twenty-one original variables: Factor 1 ‘cooking coal smoke’, Factor 2 ‘heating coal smoke’, and Factor 3 ‘ventilation’. We found that cooking coal smoke was significantly and negatively associated with forced vital capacity (FVC, $\beta = -238$ ml, $p < 0.01$), and with forced expiratory volume at one second (FEV1, $\beta = -248$ ml, $p < 0.01$) with respect to an increase in the Q-spread of the factor score. The other two factors were not significantly associated with either of the lung function parameters. Our study suggests that independent effects of exposure to indoor air pollution may exist for the children in this study.

5.4-3 Association of health effects and NO2 concentration in indoor air of the residences

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This study was designed to evaluate the relationship between different health outcomes, indoor and personal NO2 concentration for 39 housewives in Siheung city in Korea during November and December in 2003. In the results of this study, variations of pulmonary function were showed significantly, even though participants didn’t feel any subjective symptoms or felt them in low level. Therefore, assessing the health effects from pollution under low level, it can be suggested that using objective health outcome such as pulmonary function test rather than subjective symptom score show more conclusive and clearer relationship.

5.4-4 Investigation of exposure-uptake relationship of fine particulate toxic-load among inhabitants of steel plant environment in central India

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The work reported here describes the estimation of personal exposure to PM10 deposition and status of selected toxic metals in the respiratory tract washout samples obtained from the 20 subjects residing in township of an integrated steel plant located in Bhilai, District-Durg of Chhattisgarh State. All the subjects selected were sampled for personal PM10 exposure using personal dust samplers during winter 2004. Collected samples of PM10 and respiratory tract washouts were analyzed for selected toxic elements (Pb, Cr, Cd, Co, Ni, Mn and Zn) using Atomic Absorption Spectrophotometer.

Personal PM10 exposure levels were found between 2.6–9.3 µg/m³ for category-A; 3.5–23.2 µg/m³ for category B and between 9.3–48.6 µg/m³ for category C. The results of chemical analysis of PM10 samples shows the higher risk associated with the housewives who spends more than 95% of their time indoors. Good positive correlation coefficient values between average PM10 toxic-load and respiratory tract washout concentrations are found. The result shows slightly higher susceptibility for respiratory damage in female.

5.4-5 Respiratory health of teachers in mould damaged school and the effects of remediation

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Effects of indoor mold exposure on teachers health were studied before, during and one year after mold remediation in four different school centers.

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5.4-6 Indoor air quality (IAQ) and respiratory symptoms among children in tropical Singapore child care centers employing different ventilation strategies

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This paper summarized the current results of the IAQ characteristics in 104 child care centers (CCC) and the corresponding respiratory health symptoms of attending children employing 4 different ventilation strategies. Temperature, relative humidity and ventilation rates of naturally ventilated CCCs were consistently higher than that of air-conditioned CCCs. The lower ventilation rates in air-conditioned CCCs results in higher occupant related CO₂ and bacteria concentrations but lower airborne PM₂.₅ and total fungi from the outdoors. On the contrary, naturally ventilated CCCs were not capable of preventing outdoor PM₂.₅, ozone and total fungi ingress into the centers due to the high air ventilation rates. This study indicated that there were no significant differences in both current and acute asthma and allergic symptom prevalence in different ventilated CCCs with the exception of asthma exacerbations leading to ER visits (highest in ACMV). There were also no significant differences in frequency and prevalence rates between CCC groups highlighting possible confounding effect of high number of children present in naturally ventilated CCCs.
5.5 Combustion products and health impacts (especially in rural areas in developing countries)

5.5-1 Indoor air pollution from firewood combustion in traditional houses of Nepal
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Indoor air pollution was investigated during the winter in traditional houses and personal samplers provided to their residents in the Dhading district of Nepal. Results show that the concentration on each floor varies with the position of the staircase. The maximum CO, CO2, SPM, NO2, and HCHO concentrations were 185.5 ppm, 2509 ppm, 11.13 mg/m3, 84.7 ppb and 166.9 ppb, respectively in the indoor spaces. This pollution is higher than the standard. The concentrations of CO, CO2 and SPM are highly correlated to the area of the apertures in the kitchen. The iron stove proved highly effective in reducing the indoor air pollution of the investigated house and the residents’ samplers.

5.5-2 Linkages between climate mitigation policy and indoor air pollution from solid fuels
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In its Third Assessment Report (IPCC 2001), the Intergovernmental Panel on Climate Change concluded that climate policies designed to mitigate greenhouse gas emissions are a win–win proposition. They relied on models that predict climate policy will bring significant benefits for developed countries, and even larger benefits for developing countries. The rationale behind these findings is that climate policies will reduce fossil fuel consumption and their associated local air pollution, hence reducing health impacts of poor air quality yielding ‘ancillary benefits’ (i.e. indirect or side benefits) offsetting, and at times exceeding, the mitigation costs. IPCC’s assertions are reflective of conditions where fossil fuel consumption is the major determinant of urban outdoor air quality, and indoor and outdoor air quality are strongly correlated. Our research examines the validity of the ancillary benefit models in developing countries where the continued use of biomass and household coal determine indoor air quality and are estimated to result in 1.6 million deaths annually. We use a case study analysis for India to illustrate linkages between climate mitigation policy and household indoor air pollution. The significance of this research is to incorporate biomass, non-commercial household energy sources, and indoor air pollution in the analysis of international climate policy impacts.

5.5-3 Exposure assessment for indoor air pollution associated with household fuel use in rural districts of Southern India – results of monitoring exercises in Tamil Nadu and Andhra Pradesh
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Indoor air pollution resulting from combustion of biomass fuels in rural households of developing countries is now recognized as a major contributor to the global burden of disease. Accurate estimation of health risks has been hampered by a paucity of qualitative exposure information. This paper reports the results of studies that quantified the daily average concentrations of respirable particulates in over 900 rural homes of Andhra Pradesh and Tamil Nadu, India and recorded time activity data from nearly 2000 individuals to reconstruct 24-h average exposures. The mean 24-h average concentrations ranged from 70 to 730 mg/m3 in gas- versus solid fuel-using households, respectively and mean 24-h average exposures ranged from 80 to 570 mg/m3. Among solid fuel users, the mean 24-h average exposures were the highest for women cooks and were significantly different from men and children. The data generated are being used to facilitate the development of a regional exposure database and enable better estimation of health risks.

5.5-4 The control of air quality in commercial kitchen
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The paper reports on a study of indoor air quality in a simulated kitchen environment. The report illustrates the influence of makeup air on exhaust hood performance. Computational fluid dynamics and professional software Airpak 2.0 were used to explore the condition in the commercial kitchen and to assist with experimental design. This simulation reveals a complex flow situation that the thermal plume from the cook top interacts with the exhaust hood. The paper shows the differences of airflow pattern among air curtain supply, front face supply and backwall supply integrated with the local hood.

5.5-5 Residential exposures to particulate and carbon monoxide in Pakistan
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Many people in developing countries rely on biomass fuels for cooking. Such biomass combustion can result in high levels of indoor air pollution. It is likely that rural populations in developing countries are the most highly exposed to air pollutants from biomass combustion. Such air pollutants include particulates and other combustion by-products. Several studies have suggested that exposure to very high levels of par-
ticular matter might be a significant risk factor for respiratory illness. We measured particulate matter with aerodynamic diameter 2.5 μm or less (PM<sub>2.5</sub>) and carbon monoxide (CO) in houses with different cooking facilities in rural areas of Pakistan to improve our understanding on the extent and severity of indoor air quality from biomass combustion. CO levels were measured in 14 houses during the summer, and CO and PM<sub>2.5</sub> were simultaneously measured in 15 houses during the winter. CO and PM<sub>2.5</sub> concentrations were continuously measured by electrochemical sensor with data logger and Dustrak, respectively. In summer, CO levels were 21.6 ppm in wood burning house and 2.9 ppm in natural gas houses. CO levels in winter were slightly higher but the difference by fuels was maintained. PM<sub>2.5</sub> concentrations had averages of 10390 μg/m<sup>3</sup> in wood burning houses and 260 μg/m<sup>3</sup> in natural gas houses. PM<sub>2.5</sub> and CO concentrations were simultaneously increased during cooking hours. Extremely high peaks PM2.5 and CO levels, up to 287 mg/m<sup>3</sup> (=287000 μg/m<sup>3</sup>) and 168 ppm of one-minute average, were observed in houses with wood burning stoves during cooking periods. It is important to note that people, especially female and children, is exposed to high level of particulate during cooking.

5.5-6 An overview of studies on the relationship between indoor coal burning and lung cancer – indoor air PAHs exposure, risk assessment, genetic susceptibility and lung cancer in Xuan Wei, China (1979–2003)

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In Xuanwei county, Yunnan province, the age-adjusted lung cancer mortality rate was 27.7/100 000 in males, which was among China’s highest, and 25.3/100 000 in females, which was China’s highest. To study the main risk factors for lung cancer in Xuanwei and the relationship between the exposure to indoor coal burning and the disease, we conducted a multidisciplinary research based in Xuanwei. The main findings of these studies were: 1. No evident association of lung cancer with industrial pollution; 2. Smoking was not the main risk factor for lung cancer in Xuanwei; 3. There was a significant association between exposure to indoor burning of different types of fuel and lung cancer mortality rate, with a significantly increased lung cancer mortality rate related to the indoor air pollution from smoky coal emissions that contain high levels of polycyclic aromatic hydrocarbons (PAH); 4. The association between the exposure and lung cancer risk might be increased by GSTM1 null genotype as well as overexertion of the P53 protein. It is likely that the lung cancer excess in Xuanwei county results from the complex interaction of genetic and environmental factors that will require further research to be understood.

5.5-7 Domestic combustion of biomass fuels and respiratory symptoms among women in Zimbabwe

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Indoor air pollution is a major problem affecting most of the developing countries. It ranks third among preventable risk factors such as malnutrition and lack of clean water and sanitation. The aim of the study was to examine the influence of domestic environment on adverse health effects in women and children in Zimbabwe. Multistage sampling of households was applied to recruit one hundred women and their children (100) from households in Gwanda district. A questionnaire survey including questions on health status of women, and some house characteristics was conducted. Forty-eight households were monitored for respirable particles and carbon monoxide. According to the results median exposure levels to carbon monoxide (25 mg/m<sup>3</sup>) and respirable particles (2.51 mg/m<sup>3</sup>) exceeded the recommended WHO standards. Furthermore, the logistic regression analysis demonstrated that exposure to higher levels of RSPs is a significant factor for respiratory symptoms in women (OR = 2.89, 95% CI 1.044–8.005). The domestic environment in rural areas of Zimbabwe may play an important role for the development of respiratory symptoms in women.

5.5-8 Indoor air quality and respiratory symptoms in children in Ulaanbaatar (Mongolia)

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Indoor air pollution and its impact on respiratory symptoms in children in Ulaanbaatar, Mongolia, was studied. Respiratory symptoms and levels of indoor air pollution in three main types of dwellings, the gher, the house and the apartment were recorded. Results showed that children living in gher and houses reported higher levels of respiratory symptoms than those living in apartments. Levels of carbon monoxide and particulate matter were significantly higher in gher and houses than in apartments. The average level of particulate matter for all dwellings was substantially higher than accepted standards. Almost one third of dwellings had carbon monoxide levels higher than accepted standards. These results highlighted that children in Ulaanbaatar have been exposed to high levels of pollutants in their domestic environment and that the level of exposure to indoor air pollutants and the level of respiratory symptoms are influenced by the type of dwelling the child is living in.

5.5-9 Mass size distributions of fine particulate matter from cooking and estimation of the deposition in the human respiratory system

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Particulate mass size distributions during cooking and non-cooking periods in three Indian urban household kitchens were measured. Based on these mass size distributions, fraction of particulate deposition in the respiratory system were calculated for a healthy Indian female under light physical exertion condition by a deterministic lung deposition model. Cooking generated very high concentration of particles, 4 to 5 times more than the non-cooking periods. Cooking generated particles predominantly in accumulation mode (0.05–0.2 μm) whereas during non-cooking periods particulates found in coarse mode. Also, during frying process, the particulates were found to have a predominant coarser/droplet mode with MMADs 0. 096 ± 0.004 μm and 0.64 ± 0.11 μm with GSDs 1.41 ± 0.07 and 2.25 ± 0.2 respectively. The deterministic model used in this study has been modified to incorporate rate respiratory physiological parameters. The highest deposition was observed in pulmonary region during cooking periods, regardless of variation in cooking conditions. The respiratory deposition has shown significant relationship with physiological parameters that varied between different geographical regions inside the country.
5.5-10 A system approach to reducing indoor air pollution: A demonstrated case of increase in productivity among Nepalese women living in the village of Dahachowk of Kathmandu valley

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Dahachowk village situated just 10Km south-west of Kathmandu valley is an example for the developers to note how the development process does not percolate to even the areas which are adjacent to the developed city. Awareness programs mostly targeted to the remote villages have very little success rates and are proved to be very expensive. For the same situation, the villages in the peripherals of cities are ignored so as to result in decrease of the peoples' output affecting economy. This has become of the people of Dahachowk village in Kathmandu valley, especially of the women as regard to their exposure to the indoor air pollution since they are the ones that spend most of their time in the ill managed kitchen feeding their family. The major source of energy for cooking purpose for the women of Dahachowk village is the firewood that is gathered from the nearby forests. The village having approximately 300 households with about 1800 people living in, use 24 tonnes of firewood each day. The posters presented show the before and after situation that has prevailed among the women of Dahachowk village who are the part of the system now. The presentation reflects on sustainability of the actions where, all household women are involved in the cycle that persuades continual improvement of the indoor air quality situation in their kitchen. The women follow the deming’s cycle of Plan, Do, Check and Act (PDCA) for reviewing and improving their indoor quality.

5.5-11 Utility of coal-biomass briquette for remediation of indoor air pollution caused by coal burning in rural area, in China

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In order to evaluate utility of coal-biomass briquette (BB) as both the residential fuel and the countermeasure for indoor air pollution, such as fluorosis, we had housewife used BB and mixed fuel (MF) containing raw coal and clay for several days in rural area of Chongqing, respectively, and measured SO2 and fluoride concentrations above cooking stove and in kitchen, and personal exposure to SO2. Taking account of both the emission amounts of sulfur and fluoride per fuels and the amounts of fuels used, the results of fieldwork showed that SO2 and fluoride concentrations with BB combustion in indoors decreased compared with MF combustion, especially above cooking stove. Thus, it was revealed that BB had possibility for remediation of serious health effects.

5.5-12 Spatial distributions of indoor household concentrations of multiple air pollutants in four Chinese provinces

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Exposure to various indoor air pollutants from household use of solid fuels depends on fuel, stove, housing characteristics, and stove use behavior. We monitored three important indoor air pollutants – respirable particles (RPM), carbon monoxide (CO), and sulfur dioxide (SO2) – in four poor provinces in China, to investigate spatial patterns of pollution. The two biomass burning provinces had the highest RPM concentrations (>700μg/m3 in Neimeng; 351–661μg/m3 in Gansu); lower RPM concentrations were observed in the two primarily coal-burning provinces (202–352μg/m3 in Guizhou; 187–371μg/m3 in Shaanxi). The two primarily biomass-burning provinces also had higher CO concentrations (>7 ppm in Neimeng; 4.8–11.3 ppm in Gansu). Among the two primarily coal-burning provinces, Guizhou had lower concentrations of CO than Shaanxi (<2 ppm in Guizhou versus 2–13.3 ppm in Shaanxi). In the two coal-burning provinces, SO2 concentrations were substantially higher in Shaanxi than Guizhou. Relative concentrations in different rooms illustrate that in northern provinces heating is an important source of exposure to indoor pollutants from energy use.

5.5-13 Knowledge of hazards from indoor air pollution from household energy use in rural China

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Indoor air pollution from household use of biomass and coal is a leading environmental health risk in many developing nations, and directly or indirectly linked to a number of the Millennium Development Goals, such as environmental sustainability, reducing child mortality, and gender equity. We use data from four poor provinces in China (Gansu, Guizhou, Shaanxi, and Neimeng) to assess the knowledge of hazards associated with indoor air pollution. Using this detailed comparative study in these four Chinese provinces, we conclude that broad health education – which simply provides information on the hazards of risk and available interventions – is insufficient for successful risk mitigation. Rather, there should be emphasis on the economic and infrastructure needs of technology dissemination, coupled with understanding the details of behaviors that affect exposure and presenting users with alternative behaviors.
5.5-14 Comparative study of two methods for indoor CO monitoring
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A comparative study of two indoor CO monitoring methods, electrochemistry and Non-Dispersive Infra-Red (NDIR), had been conducted in a certain temperature and humidity. Onset HOBO CO Logger (HOBO), an electrochemical monitor and GXH-3050 IR CO Analyzer were selected to measure indoor CO concentration. Some statistical methods such as linear regression, statistical correlation, paired-samples t test were used to analyze the CO data by two monitoring methods. The results proved that the data get by two kinds of monitor had strongly correlativity, but the difference was significantly. Correcting the HOBO CO data by correction coefficient 0.58, and then made paired-samples t-test with NDIR data, the result showed that two sorts of data had no significant difference. So it is feasible to apply the simple and convenient Onset HOBO CO Logger instead of the complex GXH-3050 IR CO Analyzer in a certain temperature and humidity, it will be meaningful for the far rural area to monitor indoor CO.

5.5-15 Evaluation of improved stoves as a household intervention to reduce indoor air pollution in Guatemala and Mexico
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Household air pollution is a major source of ill-health in the majority of the world, through the use of solid fuels in stoves that emit pollutants directly into the interior of the home. There have been many programs to install improved stoves in these rural homes, although initially as a measure to conserve resources by improving efficiencies and more recently as a measure to improve health. There have been few systematic efforts to evaluate the impacts of these stoves in reducing indoor air pollution levels and in improving health largely as a result of lack of tools and methods that are available to stove manufacturers and disseminators that are suited to this task. Further the methodologies applied have not been standardized between different research efforts making comparisons difficult. We have designed easily accessible indoor air pollution monitoring tools for use by non-governmental organizations (NGOs) to determine the degree to which an improved stove program lowers indoor air pollution levels in households. This paper is one of two at the conference that present the results of one of the first efforts to provide stove projects around the world with similar tools, methodologies and training to evaluate the impacts of improved stoves on reduction of air pollution. Edwards et al present the results of the deployment of these monitoring methods in two projects in Latin America. Here we present the results of before-and-after IAQ measurements (particulates and carbon monoxide) from two stove projects in India, which employed common sampling designs, equipment, and criteria in household selection.

5.5-17 Mechanisms of exposure to fluorine from household coal use in China
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Coal is a commonly used fuel in China. Most of the coal used by the study households in Guizhou province is bituminous coal and/or anthracite, obtained from surface exposures. In parts of the province, which include the study region, these coals have undergone mineralization, causing their enrichment in potentially toxic trace elements such as arsenic and/or fluorine. In most rural households in Guizhou, coal is generally burned in metal stoves with limited insulation and ventilation. Health data also indicate relatively high prevalence of dental/skeletal fluorosis and arsenic toxicity in Guizhou. We investigated the routes of exposure to fluoride from coal use in households in rural Guizhou by monitoring fluoride in indoor air and in food dried over the stove. The 24-hr average concentration of fluoride in air in Guizhou province were substantially lower than the 8-hr time-weighted average TLV values of 2500 μg/m³ from ACGIH guidelines. Te upstairs attic, where the chimneys ended and food was dried, consistently had the highest concentrations of pollutants. The low concentrations therefore mean that direct inhalation may not contribute significantly to exposures but may be mediated by bioaccumulation through secondary deposition on food. Data on fluoride in fresh and dried food are used to investigate this hypothesis.

5.5-18 Indoor levels of benzo(a)pyrene, phenanthrene and fluoranthene in homes with domestic wood burning
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Objectives Polycyclic aromatic hydrocarbons (PAHs) are products of combustion processes and domestic wood burning is considered to make up for a significant part of the emissions. There is limited knowledge about the levels of PAHs inside homes with domestic wood burning. The aim of this study was to investigate the impact of domestic wood burning on indoor levels.

Method Stationary measurements were performed in the living room of 23 non-smoking homes with (n = 13) or without (n = 10) wood burning appliances in the small Swedish town Hagfors (winter 2003). Simultaneous measurements were performed at an outdoor site. The particulate and gaseous phases of PAHs were collected with active sam-
pling (2L/min) for 24 hours. The PAHs were analysed using GC-MS and detected with Selected Ion Monitoring. The differences in PAH levels between wood burners and the reference group were assessed using the Wilcoxon rank-sum test. Spearman rank correlation coefficients were used to express correlations between the levels of the PAHs.

**Results** Fluoranthene and phenanthrene were found in both the gaseous and the particulate phases, whereas benzo(a)pyrene was found only in the particulate phase. Significantly higher (p = 0.03, one-sided) indoor concentrations of benzo(a)pyrene were found in homes with wood burning compared to the reference houses (medians 0.49ng/m³ versus 0.10ng/m³). Higher indoor concentrations of phenanthrene (medians 11ng/m³ versus 7.6ng/m³) and fluoranthene (medians 1.3ng/m³ versus 0.75ng/m³) were also found but the differences were not statistically significant. The median outdoor concentrations of benzo(a)pyrene, phenanthrene and fluoranthene were 0.35ng/m³, 8.3ng/m³, and 2.6ng/m³, respectively. No correlations between these PAHs were found in the separate groups.

**Conclusions** Domestic wood burning seems to increase the indoor levels of benzo(a)pyrene, and possibly also phenanthrene and fluoranthene.
5.6  SBS symptoms

5.6-1  Associations between ‘sick building syndrome’ (SBS), gender and personality traits
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The aim was to study associations between SBS, and personality characteristics measured by Antonovsky’s Sense of Coherence (SOC) and Karolinska Scales of Personality (KSP), in a follow-up study of subjects initially working in buildings with suspected indoor air problems. The Sense of Coherence Scale is defined as a global orientation that expresses the extent to which one has a pervasive, enduring though dynamic, feeling of confidence that: The stimuli deriving from one’s internal and external environment in the course of living are structured, predictable, and explicable. The resources are available to meet the demands posed by the stimuli. These demands are challenges worthy of investment and engagement. A person with a strong SOC is less likely to perceive many stressful situations as threatening and anxiety provoking than one with a weak SOC. The KSP is a self-report personality inventory based on psychobiological theory and medical symptoms. A cohort of 154 subjects in 19 buildings was followed from 1988 to 1998. Information on 16 SBS-symptoms was gathered by a postal questionnaire, including KSP and SOC. Most of the buildings were well ventilated (460–1280 ppm CO2), formaldehyde (11–33 µg/m3) and 2-ethyl-1-hexanol levels (1–4 µg/m3) were low, and TVOC was 30–710 µg/m3. SBS was more common in women, younger subjects, and in those with atopy. Subjects leaving the problem buildings had a decrease of symptoms, compared to those remaining in the same workplace building. Women had lower SOC-score, and those with a low SOC had 2–3 times more symptoms than those with a high SOC. Those with low SOC developed more new symptoms (p < 0.05), in particular ocular symptoms (p < 0.05), during the follow-up period. Subjects with a higher number of symptoms were found to display higher degree on the KSP-scales: Somatic Anxiety (p < 0.001), Psychasthenia (p < 0.001), Inhibition of Aggression (p < 0.05), Detachment (p < 0.05), Suspicion (p < 0.01), Indirect Aggression (p < 0.01), and Verbal Aggression (p = 0.04, 0.05). In particular, ocular, respiratory, dermal, headache, and tiredness were related to anxiety- and aggressivity related scales. The longitudinal study showed that somatic and psychic anxiety, detachment and suspicion were predictors of increase of symptoms during the follow-up period. In conclusion, we found that personality vulnerability seems to play an important role in both prevalence and change of symptoms over time in people initially working in buildings suspected to have environmental problems. There are indications that Sense of Coherence can detect personal vulnerability in relation to environmental stress. Symptoms reported in the buildings with suspected indoor air problems are partly reversible, as indicated by the reduction of symptoms among those leaving these buildings. The KSP ratings in the study group did not differ from the mean personality scale norm scores, calculated from an external reference group. Subjects with higher SC were found to display higher degree of anxiety and indirect aggression. In addition, ocular, respiratory, dermal, and systemic symptoms (headache and tiredness) were significantly related to anxiety- and aggressivity related scales. The usefulness of personality scale scores when focusing on risk subjects for such symptoms is discussed. A multi-disciplinary approach including both personality aspects and building investigations can increase understanding of the indoor environmental problems.

5.6-2  A study on the acute irritation responses and molecular mechanism of gaseous formaldehyde
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To find out reliable biomarkers in China for acute irritation caused by indoor air pollutants, we carried out this study. A controlled human exposure experiment was used as the main research method. Subject eyes were exposed to gaseous formaldehyde at different doses (0 mg/m3, 1.0 mg/m3, 2.0 mg/m3, 3.0 mg/m3) five minutes a day for 4 days. The content of substance P in nasal lavage was determined by radio immune assay (RIA), and the blinking frequency and irritant intensity of their eyes were measured at the same time. The results showed that there were dose-dependent effects between blinking frequency and formaldehyde levels (r = 0.980, P < 0.05), and so were there between irritant intensity and formaldehyde levels (r = 0.985, P < 0.05). The content of substance P in nasal lavage increased after exposures, especially after the exposure of 3 mg/m3 formaldehyde (p < 0.05). This might explain that formaldehyde could stimulate trigeminal nerve ends of the eyes, which would release substance P from its nasal branches through axon reflex.

5.6-3  Field survey on indoor air pollution and factor causing symptom in sick houses
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In order to determine the factors of causes of SHS, a field survey on indoor air quality and occupants’ health conditions was investigated in 53 sick houses. In conclusion, concentrations of formaldehyde in 66%, acetaldehyde in 78% and TVOC in 60% of rooms exceeded the Japanese guidelines, respectively. While VOC concentrations decreased as building age increased, carbonyl compound concentrations hardly changed. There are many houses where air change rate did not satisfy the required value, 0.5 h−1, of the Building Standard Law of Japan, in which chemical substance concentration tend to be very high. Concerning health conditions, many occupants reported eye irritation and coughing. However, the relationship between chemical substance concentration and subjective symptoms is not clear and the causes of symptoms are different between individuals.

5.6-4  Longitudinal studies of IAQ and comfort problem in mechanically ventilated buildings
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This paper had the overall objective of investigating strategies to assess indoor air quality (IAQ) and health symptoms and perceptions of
building occupants. It aimed at understanding causes of sick building syndrome (SBS) and other sources of occupant complaints using these strategies. The strategies focused on questionnaire methodology and standardization, exposure assessment, intervention approaches, and data analysis. The findings of the research provide insight to SBS problems and suggest further research opportunities for investigating building-related health and comfort issues.

### 5.6-5 The medical and social prognosis of sick building syndrome – a follow-up study focusing on female patients

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A follow-up questionnaire focusing medical and social status, actions taken and personality traits was sent to 239 patients with sick building syndrome (SBS) registered at the University Hospital in Umeå, Sweden. The response rate was 79 percent. As females constituted 92 percent of the respondents all statistical analyses were restricted to women. Almost half of the respondents had been exposed to environments with visible water damages. Fatigue, irritated eyes and facial erythema were the most common symptoms. Nearly half of the patients claimed that the symptoms were more or less unchanged after 7 years or more. Twenty-five percent of the patients were on the sick-list and twenty percent drew disability pension due to SBS-symptoms at follow-up. Symptoms were often aggravated in different situations in everyday life. No important deviations concerning personality factors were found. The results support that early and comprehensive measures for rehabilitation are essential for these patients.

### 5.6-6 Sick building syndrome: indoor pollutants levels and prevalence of symptoms among workers of a sealed office building

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To evaluate the association of work-related symptoms with the concentration of the main indoor pollutants, a self-administered questionnaire was given to 1736 office workers of a 42 storey sealed building. Indoor pollutants were measured in 7 selected floors. Standardized international methodologies were used to investigate the indoor concentration of CO₂, aerodispersoids and volatile organic compounds. Upper respiratory symptoms presented a great prevalence, around 40%, whereas lower airways manifestations frequencies were below 20%. The most prevalent symptoms were tiredness and headache, over 50%, although these were the least improved symptoms out of the work place. Nasopharyngeal and ophthalmic manifestations seem to be the more affected by the internal environment, for they present the highest indices of improvement out of the workplace. The building’s levels of CO₂, aerodispersoids and TVOCs were higher than the recommended. The great prevalence of Sick Building Syndrome symptoms may be related to the levels of indoor pollutants.

### 5.6-7 Wood preservative-associated health effects: a case report

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A possible relationship between health effects in a single mother and her two daughters and a possible wood preservation substance exposure at their former dwelling two years ago will be clarified. Different wood preservatives [pentachlorophenol (PCP), lindane, dichlofluanid, furmecycloxy] were analyzed only in wood probes by a foreign lab. This constellation of wood preservatives is very unlikely because commercial products never contained this mixture. Concerning the health disorders of the mother (mastitis, headache, intercostal neuralgia), her first daughter (headache, eye infections, fatigue, aggression) and her second daughter (head-ache, eye pains, fatigue, difficulties in concentration) basic medical investigations were not performed. It is concluded, that in case of suspected exposure-related health disorders a contemporary and locally close exposure assessment in substance dependent intake-relevant media and body fluids must be performed. Additionally, a valid differential diagnosis is necessary which shall not only focus on environmental but also on physical and psychical factors.

### 5.6-8 Experiences with environment-related health disorders in the German speaking area

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In the German speaking area, environmental medicine outpatient clinics, counseling centers and practicing physicians have observed environment-related health disorders in patient groups of mixed age, as well as for groups consisting only of adults resp. children. In all patient cohorts the mainly suspected causative factors for health disorders were located in the indoor environment. Practicing physicians suspected correlations between environmental factors and health disorders between 36% and 45%, environmental medicine outpatient clinics and counseling centers between 4% and 34% for mixed-age groups, and between 0% and 24% for adults as well as between 9% and 13% for children.

### 5.6-9 Risk factors in the onset of symptoms related to the sick building syndrome: a prospective population based study

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**Aims** To identify risk factors in the indoor environment at work that are related to the onset of symptoms of the sick building syndrome.

**Methods** The study is a prospective study based on questionnaires from a random sample of adults from the Danish population. The sample comprised 2164 adults in employment, of whom 1402 who were still working and living in the same place completed a second questionnaire a year later. Logistic regression was used to examine the association between nine risk factors in the perceived indoor environment and mucous membrane symptoms and general symptoms. Information from the baseline questionnaire was used as predictors of developing new symptoms at follow-up.

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5.6-10 Sick building syndrome: symptoms prevalence among workers of a sealed office building comparing with those of a non-sealed office building

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To compare the prevalence of symptoms of sick building syndrome (SBS) among office workers, a cross-sectional study was performed, involving 1736 workers of a sealed office building (edifice 1) and 950 employees of a non-sealed, natural ventilated, building (edifice 2), in Rio de Janeiro downtown. The standardized questionnaire of the Royal Society of Health Advisory Group on SBS was used to determine the prevalence of symptoms. Upper airways and ophthalmic symptoms, tiredness and headache were highly prevalent in both buildings. Some symptoms were more prevalent in edifice 1: ‘dryness of the eyes’ 33.3% and 27.1% (p: 0.01); ‘runny nose’ 37.3% and 31.3% (p: 0.03); ‘dry throat’ 42% and 36% (p: 0.02); and ‘lethargy’ 58.5% and 50.5% (p: 0.03) respectively. The greater prevalence of some SBS symptoms in the sealed building can be related to a higher concentration of indoor air pollutants.

5.6-11 Methodological experiences from three indoor air related controlled intervention trials in offices

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Experiences from three intervention field trials were evaluated. They were controlled randomized trials, where both participants and researchers were blinded to the group status of the participants. Exposure and health indicators were measured before and after intervention. Our recommendations are as follows: The number of subjects should be determined from power calculations, taking into account the magnitude of the variation in health indicators. Inclusion of sensitive persons should be balanced against generalisability. Exclusion criteria should be considered. A comparable control group is crucial. Matching must be considered. Pre-intervention values for outcome variables should be evenly distributed between the two groups, due to regression to the mean. The blinding procedure should be evaluated. The time span of the intervention, and the length of the follow-up period should be discussed. How large a contrast in exposure is needed, to see a statistically significant difference in health outcome?

5.6-12 Socio-economic factors, lifestyle and personal attitudes influence reports of SBS-symptoms in questionnaire surveys

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Differences have been reported on indoor climate as perceived and SBS symptoms in different types of dwellings, but not been supported by technical measurements. To extend the study of the impact of non-physical factors on health, we have utilized data from a community health survey. Those who rented their flats in multi-family buildings reported a significantly higher prevalence of health problems than those who owned their flat or house. Socio-economic factors, lifestyle and personal attitudes highly influenced the health parameters, including the SBS symptoms. Therefore, when using questionnaires to assess the indoor climate, it is important to apply correct reference values in order to reduce the influence of such strong factors.

5.6-13 Indoor climate and psychosocial work environment in cellular, multi-person and open-plan offices

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To study the psychosocial work environment and the indoor environment in offices a cross-sectional questionnaire survey was performed in 11 naturally and 11 mechanically ventilated office buildings. Both buildings with cellular, multi-person and open-plan offices were studied. Half of the buildings were from the private sector while the other half consisted of public or governmental buildings. In each building 100 to 300 occupants completed a retrospective questionnaire looking back at the last four weeks. The questionnaire comprised questions concerning environmental perceptions, irritation of the mucous membrane, skin irritation, general symptoms and psychosocial factors such as: demands at work, job control, motivation, quality of leadership, social support, insecurity at work, job satisfaction, general health, mental health and vitality. Occupants in open-plan offices are more likely to be exposed to thermally uncomfortable conditions, poor air quality and noise, and they more frequently complain about CNS and mucous membrane symptoms than occupants in multi-person and cellular offices. The association between psychosocial factors and office size was weak.

5.6-14 The measurement of eye symptoms: a pilot study

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Epidemiological studies have shown that eye irritation is one of the most common symptoms reported in the indoor environment. Different terminology for eye symptomatology has been used in the literature: e.g. dry eyes, strained eyes, sore eyes, itching eyes, irritated eyes, burning eyes, tired eyes, and red eyes. A pilot questionnaire study among office workers was performed to study the dimension of eye related symptoms. Six items concerning different aspects of eye irritation were included in a questionnaire study of ergonomics among
85 employees in ten different office buildings. The six items were: ‘dryness’, ‘itching and/or irritated eyes’, ‘burning eyes’, ‘tiredness’, ‘painful eyes’ and ‘double vision or blurred vision’. Structural equation modelling together with more traditional test of internal reliability with Cronbach alpha was performed. The items ‘dryness’, ‘itching and/or irritated eyes’ and ‘tiredness’ were found to be measurements of the same construct of eye irritation (Cronbach alpha = 0.85). A thorough validation of the different constructs of eye symptoms is needed to study eye symptomatology and its causes in the indoor environment.

5.6-15 Risk factors for building-related symptoms among adolescent schoolboys and schoolgirls in the Copenhagen School Study

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Introduction
Based on data from the Danish Mould in Buildings programme (DAMIB) we have recently reported the following in a study of more than one thousand adolescent school children: when controlling for relevant confounders, the concentration of moulds in floor dust was associated with building-related symptoms (BRS) in adolescent schoolboys. In contrast, no such association was found among schoolgirls despite their higher prevalence of BRS (1). We wished to find out if a gender dependent association between mould exposure and BRS could be found in comparable population of schoolchildren – the Copenhagen School Study (2).

Materials & Methods
In total, 666 pupils aged 13–17 years, participated in the study. They occupied 53 classrooms, where technical measurements were performed. Floor dust samples were collected using the same equipment as in the DAMIB study, though there were differences in sieving and freezing procedures before culturing. Nevertheless, levels of mould CFU/g dust were comparable in the two studies. Gender stratified multiple logistic regression analyses were performed with BRS as outcome variables; asthma, hay fever, smoking habits and psychosocial working” conditions were included together with building factors as potentially relevant covariables.

Results & Conclusion
No association was found between BRS and moulds in floor dust in this population, and the patterns of risk factors for BRS were similar for boys and girls. Of person related factors the strongest associations with BRS were found for asthma, hay fever and adverse psychosocial working” conditions; of building related factors, the strongest association with BRS was presence of a mechanical ventilation system in the classroom. Also floor dust factors (inflammatory potential, bacteria and allergens) were significant covariables. Possible reasons for differences in the results of the DAMIB study and the Copenhagen School Study are discussed.

5.6-16 Prediction of SBS symptoms in office workers

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The purpose was to predict office workers reporting SBS symptoms. A random sample of office workers in the public administration in the Århus area were invited to participate in clinical measurements and to report their symptoms in the Örebro questionnaire. Ninety-nine accepted and went through the clinical measurements: Acoustic rhinometry (nasal volume), Odor threshold to butanol (sensitivity), Eye irritation provocation using CO2 (sensitivity), Tear film stability, Eye epithelium damage, inflammatory cells in the eye, Profile of Mood States (psychological status, stress), Urine cortisol, nor-adrenaline and adrenalin (stress). Work related symptoms were grouped as total, general, irritation, and skin and analyzed using multiple logistic regression. The measurements and background data (allergies, gender, age etc.) were included in the analyses. ROC-curves of predictability were established. Analyses showed a symptom profile as often seen in office workers. The preliminary analyses showed the normal relation between gender, age and symptoms. For the models related total symptoms it seems that it is possible to achieve a relatively high degree of predictability with the following predictors: Nor-adrenalin, inflammatory cells in the eyes, epithelium damage in the eye, infection diseases, education, working years, smoking. Weekly work time, gender, age. The area under the ROC curve was 0.945, indicating a very good prediction of subject with more than 2 symptoms in a three-month period. CNS symptoms had the second best prediction (area = 0.861) with the predictors: Mood state, allergy, infection diseases, gender, and age. Irritation symptoms (all irritation, nasal and eye irritation) were less predictable but were all significant (p < 0.0005). Nasal irritation was predicted by Odor threshold to butanol, Nasal minimum cross-sectional area, urine-cortisol, infection diseases, and gender. Eye irritation by urine-cortisol, working years, gender, and age. The analyses are preliminary and further results will be presented.

5.6-17 Indoor air-associated health disorders in housing office workers

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Since moving to the first floor of a bank building, Housing Office workers reported building-related health problems whereas workers on the second floor reported none. All workers were given a modified German version of the Örebro questionnaire and an on-site inspection was done. More workers on the first floor reported symptoms (up to 86%) and indoor factors (up to 100%) than did workers on the second floor (18% resp. 18%). A on-site inspection of the first floor revealed environmental tobacco smoke (ETS), a not adjustable mechanical air outlet, dust load, poorly placed visual display units (VDUs), noise, and a high exposure to sunlight. No such problems were found on the second floor. It is likely that the workers’ health problems are related to indoor air conditions. It is recommended that six months after remedial action the effectiveness of the remedial action should be examined.

5.6-18 Estimated ventilation rates and work-related symptoms in U.S. office buildings – the base study

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Insufficient information has been available on measured ventilation rates and symptoms in office workers. Using U.S. EPA data from 100 large U.S. office buildings, we assessed relationships in multivariate models between ventilation/person and lower respiratory and mucous membrane symptoms. Three preliminary ventilation estimates were used, based on CO2 ratio in airstreams, peak indoor CO2 concentrations, and volumetric estimates of flow rates. Ventilation rates (VRs) from 6–17 cfm/person above the current 20 cfm/person guideline for offices were associated generally with reduced symptom prevalence, but further benefits were not evident from higher VRs. For all ventilation estimates, higher occupant density was independently associated with more symptoms. Findings suggest that VRs somewhat above current guidelines would reduce symptoms in office workers, and that occupant density may play an unrecognized role in ventilation requirements. Different findings for the various ventilation estimates were surprising. Clarification of these relationships, and validation of VR measurement methods are necessary.
Many studies have associated moisture or mold in residences with respiratory symptoms, but few studies have been conducted in office buildings. We assessed associations between moisture and ventilation system contamination and lower respiratory and mucous membrane symptoms in the U.S. EPA BASE data from 100 U.S. office buildings, using multivariate regression models. One set of models showed lower respiratory symptoms almost tripled with lack of cleaning of drip pans under air-conditioning cooling coils [odds ratio (95% confidence interval) = 2.8 (1.2–6.5)]. Other models associated lack of cleaning of either drip pans or cooling coils, and water damage in mechanical rooms, with increased mucous membrane symptoms. Some moisture-related risks found by other studies were not replicated here. Overall, findings suggest that moisture or contamination in ventilation systems or occupied spaces in office buildings may have adverse health effects. Studies with more rigorous measurement of environmental factors and health outcomes are necessary.

5.6-20 Serum levels of volatile organic compounds in patients with sick building syndrome symptoms

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We developed a method for measuring volatile organic compounds (VOCs) in serum using a headspace-gas chromatography/mass spectrometry. Stable isotope-labeled internal standards for each of the selected analytes were used to improve analysis precision. The method was sensitive with detection limits between 0.1 and 1 ng in 1 mL of serum for all of the analytes. We measured serum VOC concentrations of 18 patients with symptoms of sick building syndrome and 32 healthy controls. Three of the most often detected VOCs were p-dichlorobenzene, xylene, and toluene in these 50 subjects. Although the differences between the patients and the control, it was revealed that the patients had lower serum levels of VOCs than the controls. We conducted follow-up investigations on two female patients who complained of strong symptoms.

5.6-21 Questionnaire survey about Sick House Syndrome in Japan

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At present, no single environmental factor or group of factors has been established as the single cause of sick building syndrome (SBS). Recently a similar syndrome has been reported with increasing frequency in airtight new houses in Japan, that is, Sick House Syndrome (SHS). We conducted the survey concerning SHS in Fukushima city in 2003. We sent the questionnaire to 1050 new houses. The items of the questionnaire were the conditions of the house, the indoor environment conditions, health conditions of the family, and symptoms related to the indoor air. Frequent symptoms of the families were nasal obstruction, eye strain, breathlessness, skin eczema, skin itching, weariness, languidness, abdominal symptoms, allergic reaction, asthma. Popular indoor ventilation methods were to open the window, to use ventilation system in each room. Ventilation systems were located mainly in the kitchen and bathroom. On the contrary there are few in bedroom and study room.

5.6-22 Prevalence of sick building syndrome reported in literature

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Country-based prevalence and characteristics of sick building syndrome (SBS) may help for a better understanding of this syndrome. The aim of the present study was to analyze SBS prevalence reported in scientific literature. Therefore, a literature research was performed using Medline® and the Proceedings of Indoor Air available since the conference in 1987. Totally, 20 articles dealt with the prevalence of SBS as classification and not only with the prevalence of single SBS-related symptoms. Out of these 20 papers, six articles dealt with SBS prevalence in a whole country, nine with SBS prevalence in a special region of a country and five with SBS prevalence in special building types. In conclusion, there is internationally a lack of representative country-based studies on SBS which allow a valid estimation of SBS prevalence. This data base should be assessed for a better understanding of this syndrome.

5.6-23 A case study on use of QESI® as a questionnaire for a screening

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QESI® (Miller and Prihoda, 1999a) was applied to 498 subjects who had not been diagnosed previously as having Multiple Chemical Sensitivity (MCS) or Sick Building Syndrome (SBS) recruited from the general population of Miyagi prefecture, Japan. Seventeen (3.8%) of 440 subjects who returned valid completed questionnaires were classified as having symptoms ‘Very suggestive’ of MCS and/or SBS using the four-classification system of Miller and Prihoda (1999a). We conducted detailed telephone interviews with these 17 individuals. All of them were visiting local hospitals on an outpatient basis with diagnoses other than MCS and SBS. Therefore, we recommended they undergo a medical check by MCS medical experts and indoor air quality assessment. Thirteen (9%) subjects participated in air quality monitoring and 7 of 13 participated in medical by MCS medical experts. In nine houses of 13 subjects who participated in indoor environmental quality (IEQ) survey, acetaldehyde (9/9), formaldehyde (8/9), total volatile compounds (TVOCs) (6/9), and parachlorobenzene (3/9) levels were above the respective guideline values for indoor air concentrations outlined by the Ministry of Health, Labor, and Welfare of Japan and were presumed to act as factors contributing to the subjects’ hypersensitivity, and onset or development of symptoms. All of the 7 subjects who participated in both the medical check were diagnosed as having MCS and/or SBS by the expert physicians. These results of indoor air quality
6.24 An integrated approach to eye irritation in the office – importance of the relative humidity?
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Merging indoor air science, occupational health and ophthalmology is necessary to understand office-related eye irritation complaints. It is important to determine: 1) Eye blinking alteration like decreased blink frequency plays a role in the precorneal tear film (PTF) integrity and whether this causes increased reporting of eye symptoms? 2) Indoor air pollution causes PTF alterations and symptoms? 3) PTF alterations are associated with thermal factors, like the relative humidity? PTF alteration leads to eye complaints that may be caused by (i) thermal factors, (ii) demanding task content (increases of the expanse of the ocular surface), and (iii) individual tear film characteristics. These factors progressively increase water loss and thinning of the PTF, which causes dry spots and dryness on the PTF. Another cause is irritating organic compounds, in addition to oxidation mixtures that are formed in reactions between ozone and certain alkenes (e.g. terpenes). Experimental findings in the literature support that eye irritation may be alleviated by high pericocular relative humidity.

6.25 The influence of major monitor factors on eye irritation related symptoms during PC work – a literature review
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The intensive use of PC has increased the concern about potential health effects. Several ergonomic factors, with regard to monitor, illumination, etc. may be important for the development of musculoskeletal and visual discomfort (occupational asthenopia). Our objective was to critically review the literature about the influence of ergonomic factors on eye irritation related symptoms (e.g. visual discomfort) and musculoskeletal discomfort with special reference to the monitor factors. The relevant peer-reviewed literature published in English between 1994 and 2004 was reviewed by database searches. In conclusion, prolonged use of PC has been shown to be a risk factor for visual and musculoskeletal discomfort. Currently, it is not clear to which extent there is an interaction between the degree of visual and musculoskeletal discomfort. Contradictory recommendations with regard to ergonomic factors exist about the prevention of visual versus musculoskeletal discomfort. Thus, a low monitor position with a downward gaze angle of 20°–55°, albeit the neck not being flexed more than 30° from vertical, appears to be optimal. Multidisciplinary studies are needed before detailed recommendations can be offered.

6.26 Objective methods for measuring effects of low dose exposures on humans indoors
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Objective, physiological methods used in studies of low-dose exposures to air pollutants occurring indoors are summarized. Such methods are used when attempting to explain biological mechanisms underlying human reactions to pollutants in indoor environments. The methods include measurements on the skin to assess changes in the barrier function of the skin and measurements of inflammation in the eyes and the nasal mucosa. The review suggests that the most promising methods are: skin humidity measurements, blinking frequency and acoustic rhinometry. There is a need of further validation of these techniques and for new methods. Three such methods are described: measurements of cerebral blood flow, CO2 and NO in exhaled breath.

6.27 Impact of risk communication in management of sick building syndrome – experiences with a newly built school building
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The management of a building-associated health problem of a newly built school building by the Public Health Office District was complicated e.g. by continuous activities of a constituted parents’ initiative, recurrent presence in the media, valuation by self-named ‘experts’, although a risk communication at the so-called round table was early as possible performed. Several, partly repeated measurements did not result in a valid explanation of the building-associated health problems. In contrast, the parents’ initiative demanded more and more measurements under different, partly unconventional conditions. The experiences showed that a successful management of building-associated health problems is only possible in consensus of all parties involved. Demands without any reason should reasonably not be accepted. If a common basis of all parties involved cannot be reached, an in risk communication experienced supervisor should be early as possible called in.

6.28 The influence of the thermal environment and air quality on people in an office environment
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The influence of the heating environment and quality of air on people in an office environment is discussed. The natural and the mechanical ventilated buildings are analyzed with the hypothesis that the appearance of health conditions associated with sick building syndrome (SBS) are influenced in a statistically significant manner by the method of ventilation. Interdisciplinary research was based on the simultaneous measurement of thermal environment and air quality, as well as on surveying the normal working activities of employees. In the survey were treat influential factors for the six months prior to the research, which dealt with health status and health problems of those surveyed as well as their current state of health and also momentarily subjective evaluation of thermal environment and air quality. Deviations between measured values evaluated by predicted mean vote (PMV) – predicted percent of dissatisfied (PPD) model (PMV-PDD) and between the subjective evaluations of thermal environment of those surveyed were
found. The subjectively stated reasons for the health problems of employees gave precedence to natural, as opposed to mechanical, ventilation, which is confirmed by the average absence from work for health reasons. The index of health was defined and analyzed for the people within a building. Findings from the study indicate a significant role for the psychological factors and psychological state of the respondents when subjectively describing the indoor environment.

5.6-29 The reported symptoms of SBS in two scriptoriums in Beijing
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To survey the indoor air quality and people’s health condition in scriptoriums. Scriptorium A and scriptorium B were chosen in one district in Beijing and questionnaires were completed by 166 office clerks (92 were female) and 100 visitors. Results indicated that most office clerks (70%) reported the environment quality in scriptoriums (Including indoor air quality, wind speed and humidity) was ‘good’ or ‘general’, while some (20%) think it was ‘bad’. Eye irritation, sore throat, tiredness are the most common reported symptoms in our survey. Their occurrence rates are 38.0%, 33.7% and 31.3% respectively. Following are headache (27.1%), dizzy (25.3%), dry and itch of skin (19.9%), tussis (16.3%), expectoration (15.1%), snivel (13.3%) and dyspnea (10.2%). The rates of reported symptoms in women were higher than in male. There are significantly different between women and man in eye irritation, sore throat, expectoration, dry and itch of skin and headache (P < 0.10). The more scores for the indoor air pollution, the higher reported rates of sore throat, tussis, dyspnea, headache and tiredness. The reported rates of those in high polluted office were remarkably higher than those in lower polluted office (P < 0.05). Compared with office clerks, more visitors think the indoor environment quality was ‘good’ or ‘general’, only 10% visitors reported that wind speed and humidity was ‘bad’. The reported symptoms were lower than office clerks in the building. There were no significant difference between female and male. Eye irritation, headache, tiredness and dizzy (25.3%) are the most common reported symptoms of SBS in our study.

5.6-30 Can the parents give a reliable assessment of the children’s school environment?
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Introduction. Parents to younger school children (grade 1 to 6) often complain about the indoor environment at school, based on short visits and comments from their children. In questionnaire surveys, parents are asked to give their perception of the school environment. The goal with this paper was to estimate the value of such information. Method and material. The parents of 19711 pupils, 7 to 13 years of age, from 89 schools in the same municipality answered a standardized questionnaire (MM080). The school personnel in the same schools answered a similar standardized questionnaire (MM040NA). Same questions about the thermal comfort and indoor air quality were used in both questionnaires. The questions had five alternatives from ‘very good’ (1) to ‘very bad’ (5). The mean was calculated for each question and each school. Results. The correlation between the assessment of thermal comfort and indoor air quality was slightly higher for the parents (Spearman’s rho = 0.75) compared to the school personnel (Spearman’s rho = 0.62). R square linear was however much higher for the parents (0.66) compared to the personnel (0.43) indicating that the parents assess the indoor environment in a more general way. The correlation between how the parents and the school personnel perceived the indoor climate was lower (Spearman’s rho = 0.53 for thermal comfort and 0.44 for indoor air quality). All correlations were however significant at the 0.01 level (2-tailed). Conclusion. Based on the results from this study it is fair to conclude that the assessment of the school environment, based on the perception of the parents is quite reliable and useful in surveys of the indoor climate.

5.6-31 Association between perceived indoor air quality and office workers’ health
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Effects of indoor environmental quality on office workers’ health and work performance have drawn much attention in recent years. However, whether the health symptoms are caused primarily by actual environmental exposures or by occupants’ perceptions is still not clear. To address this issue, we conducted a longitudinal epidemiological study to evaluate the associations between actual indoor climate and perceived indoor air quality, as well as the effects of perceived indoor air quality on office workers’ health. We investigated four large office buildings in Boston, Massachusetts, US beginning May 1997 over one year. Ninety-eight participants in twenty-one offices with open workstations were recruited. During the sampling year, we conducted intensive environmental sampling every six week. Detailed questionnaires were administered concurrently to the participants to collect information on their perceptions of health, comfort and work environments. We found perceived air qualities were concordant with actual environmental conditions. Temperature was negatively associated with participants’ perceptions of ‘too much air movement,’ ‘temperature too cold,’ ‘air too humid’ and ‘unpleasant chemical odor.’ Relative humidity had a positive correlation with ‘air too humid’ and negative correlations with ‘temperature too hot’ and ‘air too dry.’ Carbon dioxide levels were positively associated with ‘temperature too hot,’ ‘tobacco smoke odor,’ and ‘other unpleasant odors.’ Report of non-specific building-related symptoms was positively associated with ‘other unpleasant odor,’ ‘too little air movement’ and ‘temperature too cold.’ The results of this study demonstrated that occupants’ perceptions of work environments were consist with actual environmental exposures. Therefore, ill perceptions of office occupants should not be ignored.
5.7 Other health effects

5.7.1 Neurotoxicity of gaseous formaldehyde on learning and memory of mice: a morris water maze experiment

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Purpose To find out if any neurotoxicity effect exists in the mice that exposed to low-level formaldehyde.

Approach After exposed to the gaseous formaldehyde at 0 mg/m³, 1.0 mg/m³ and 3.0 mg/m³ levels, the mice were tested in Morris water maze.

Findings Results demonstrated that there were significant differences on water maze performances between 0 mg/m³ and 3.0 mg/m³ formaldehyde inhaled groups (P < 0.01) but little between 0 mg/m³ and 1.0 mg/m³ groups.

Conclusions These findings indicated that the neurotoxicity effect of formaldehyde assuredly existed, and it may occur only at middle-level (3.0 mg/m³) gaseous formaldehyde but not do at low-levels.

5.7.2 A study on protein oxidative damage in mice induced by gaseous formaldehyde

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To explore protein oxidative damage induced by gaseous formaldehyde and its mechanism we carried out this study. Mice were treated with gaseous formaldehyde at different levels (0 mg/m³, 0.68 mg/m³ and 3.0 mg/m³) for 72 hr and the protein carbonyl content was measured using spectrophotometric DNPH assay to reflect the degree of protein oxidative damage. The results show that the protein carbonyl content of brain, heart and liver tissue in mice decrease in the group of 0.68 mg m⁻³, 0.68 mg m⁻³ and 3.0 mg m⁻³ (p < 0.01, p < 0.01, p < 0.05), while increase significantly in heart and liver tissue in the group of 3.0 mg m⁻³ (p < 0.01, p < 0.01) and protein carbonyl content in brain does not have notable difference compared with the control (p > 0.05). These results indicate that the protein oxidative damage induced by gaseous formaldehyde depends on the concentration of gaseous formaldehyde. Medium concentration formaldehyde may not induce protein oxidative damage, while high concentration formaldehyde can cause protein oxidative damage in heart and liver tissue markedly and has little effect on protein of brain.

5.7.3 Oxidative damage caused by air formaldehyde exposure in organs of mice

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Few researches concern about oxidative damage of inhaled formaldehyde in medium or low concentrations. Therefore, we treated three groups of mice with 1.0 mg/m³, 3.0 mg/m³ formaldehyde and the control group inhaled fresh air. All of the mice were treated 6 hours per day for 10 days. After exposure, the activities of total superoxide dismutase (SOD), content of glutathione (GSH) and malondialdehyde (MDA) in five organs – brain, heart, lung, liver and kidney were measured. The results showed that inhaled formaldehyde caused the obvious decrease of SOD activities in five organs (P < 0.01) in 3.0 mg/m³ group, and the level of GSH in all treated groups were decreased significantly in various organs (P < 0.05) compared with fresh air group. The level of MDA in all organs of 3.0 mg/m³ were increased significantly (p < 0.05) compared with fresh air group. In conclusion, medium concentration formaldehyde gas induces significantly oxidative damage of various organs.

5.7.4 Formaldehyde effect on DNA methylation and demethylation

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Genomic DNA methylation is one of the most important epigenetic mechanisms. Existing data of indoor air formaldehyde effect on DNA methylation patterns is limited. S-adenosylmethionine, the sole methyl donor in this reaction, is generally connected to the tetrahydrofolate and the methionine – homocysteine cycle and one carbon metabolism. In mammalian systems, as a normal intermediary metabolite, endogenous formaldehyde remains in equilibrium in blood and tissues. There are two ways that endogenous FA can be involved in one carbon pool. One is the production of 5, 10-methene-THF formed by FA and THF. The second way is through the formation of 10-formyl-THF. Experiments indicate that the oxidation of 10-formyl-THF to 10-formyl-dihydrofolate takes place and 10-formyl-dihydrofolate is subsequently converted to dihydrofolate. Therefore, in light of those circles, we hypothesize that endogenous FA can act as one carbon group to participate in the process of DNA methylation or may cause demethylation through free radical injuries.

5.7.5 A new hypothesis of endogenous formaldehyde as a novel signaling molecule

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Formaldehyde, which is well known as a toxic gas and an exogenous compound, is also produced endogenously via cytochrome P450 (CYP)
mediated demethylation of compounds containing the CH$_3$N or CH$_3$O functionality. As the similarity to the accepted novel signaling molecules endogenous nitric oxide (NO), carbon monoxide (CO), and hydrogen sulfide (H$_2$S), we hypothesized that endogenous formaldehyde may be another novel signaling molecule. We first compared the three signaling molecules to give the minimal sense criteria for signaling molecule. Formaldehyde fits with all the criteria. We also proposed the possible roles of endogenous formaldehyde in order to give a basis for further study. Formaldehyde may regulate NO level, can influence the structure of macromolecules such as DNA and proteins at molecular level. This hypothesis may start a new direction in the further study on endogenous formaldehyde.

### 5.7-6 Hormesis: a common phenomenon in the bio-effects of formaldehyde toxicity

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Hormesis is a dose-response phenomenon, which is characterized by a counterintuitive switchover from low-dose stimulation to high-dose inhibition that is not infrequently encountered in the course of a toxicity assay. In this paper we provided various data, mainly our findings, to show that hormesis is a common phenomenon in the study of formaldehyde toxicity and these findings have great implications affecting study design, animal model, and endpoint selection as well as clinical applications. In the central nervous system, it has been noticed that formaldehyde can do harm to learning and memory abilities. Our findings in mice exposure to 1 and 3 mg/m$^3$ formaldehyde testified this. It is interested to notice, however, mice exposure to 0.5 mg/m$^3$ formaldehyde have better memory ability than control group. It has also been noticed that formaldehyde can induce the damage of supermolecules such as DNA and proteins, because formaldehyde is highly chemically active.

### 5.7-7 Developments of toxicological and physiological studies on formaldehyde

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This paper is a review on recent developments of the toxicological and physiological studies on formaldehyde. Hotspots involved in this topic include: (1) Formaldehyde-induced gene expression; (2) Formaldehyde-induced asthma; (3) Airway neurogenic inflammation (4) formaldehyde working as signaling molecule in body; (5) Epigenesis: methylation of DNA and proteins; (6) DNA-protein crosslink; (7) Lysine-DPC repair enzyme; (8) Formaldehyde-induced Apoptosis.

### 5.7-8 Bioreactivity of indoor PM$_{10}$s and their relationships with trace element compositions

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Plasmid DNA assay and ICP-MS were conducted to investigate the bioactivity of PM$_{10}$ and relationship between bioactivity and trace elements of PM$_{10}$ in Beijing air. Six PM$_{10}$ samples were selected to represent the indoor and corresponding outdoor environments. Among six samples, the PM$_{10}$ from the kitchen had the lowest TD50 (toxic dosage of PM$_{10}$ causing 50% DNA to be damaged), being 45 μg mL$^{-1}$, suggesting the highest bioreactivity. The TD50s of two PM$_{10}$ samples from smoker’s homes were 100 and 263 μg mL$^{-1}$, indicating a relatively high bioreactivity. Trace elements are believed to be the main reasons for oxidative damage to plasmid DNA. The ICP-MS analysis combined with the DNA assay showed that water-soluble zinc had better relationship with TD50 values than other elements, implying that watersoluble zinc might play an important role in the damage of DNA.

### 5.7-9 Moist buildings and rheumatoid diseases

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At Indoor Air 2002 we reported that in moist and mouldy buildings people suffer from rheumatoid complaints. Material analyses have suggested that bacteria may be causative agents. To investigate whether substances in moist materials can affect human cartilage, extracts from moist building materials were made. These extracts were analysed for microorganisms, endotoxins, and mycotoxins. Exposure of chondrocyte cultures to extracts in vitro showed that the extracts were damaging the cartilage cultures. In all three extracts high quantities of endotoxins (LPS) were detected. Experiments after deactivation of LPS with Polymyxin B showed that LPS are the causative agents for the tissue damage at in-vitro experiments.

### 5.7-10 Up-regulation of the mRNA-transcripts of VR1 and NFG induced by air formaldehyde

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The purpose of the present study was to determine gene expression pattern of chemosensitive receptor VR1 in the brain stem of the neonatal rat after low-level gaseous formaldehyde exposure. Male Sprague–Dawley newborn rats were exposed to clean air or 1.8 mg/m$^3$ formaldehyde for consecutive 72h and the brain stems were dissected for RNA extraction. The mRNA levels of VR1 and cytokine NGF gene were determined with semiquantitative RT-PCR. We observed that the mRNA expression of VR1 and NGF was significantly increased in the brain of the tested neonatal rats. These findings suggest that successive formaldehyde exposure may increase cytokine NGF expression and then NGF up-regulates VR1 gene expression synchronously. This may have implications for the nervous central neuro-immunological mechanisms mediating multiple chemical sensitivity (MCS), sick building syndromes (SBS), brachial hyperresponsiveness (BHR) and asthma in humans.
5.7.11 Nitric oxide level associated with gaseous formaldehyde exposure in lungs of mice

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To explore if the NOS level in airway is associated with air formaldehyde, in this study 24 Kun Ming mice were divided into 4 exposure groups (0 mg/m3, 0.5 mg/m3, 1.0 mg/m3, 3.0 mg/m3) for 72 h continuously. After exposure the NOS activities and the NO detection rate in lungs of mice were measured with reagent kits. The results showed that along with the formaldehyde ascension the NOS activities were restrained at first and then improved significantly (P < 0.05), while the NO detection rate showed the similar regulation. We suggest that formaldehyde play dual effects in vivo: at a low formaldehyde exposure (<0.5 mg/m3), the NOS activities in lungs is restrained. However, the repeated high formaldehyde exposure would alter the VR1 miRNA expression levels in the lung of mice, then the NOS activities shall be increased and the NO concentration in airway will also be ascended.

5.7.12 Nitric oxide in exhaled and aspirated nasal air as an objective measure of human response to isopropanol oxidation products and phtalate esters in indoor air

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The use of Nitric Oxide (NO) concentration in exhaled and aspirated nasal air to assess human response to indoor air pollution was tested in a climate chamber exposure experiment. The concentration of NO was measured using a chemiluminescence NO analyser. Sixteen healthy female subjects were exposed to 2 commonly occurring indoor air pollutants and to a clean reference condition for 4.5 hours. Assessments of the environment were obtained using questionnaires. The polluted conditions were perceived as worse than the reference condition. After exposure to the two polluted conditions a small increase in NO concentration (+7.2%) in exhaled air was observed. After exposure to the reference condition the mean NO concentration was significantly reduced (-12.7%) compared to before exposure. NO in nasal air was unaffected by the exposures. The results indicate an association between polluted indoor air and sub-clinical inflammation.

5.7.13 The application of thermal desorption for the analysis of trace toxic compounds in areas of human occupation

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Accidental or deliberate release of toxic chemicals into the indoor or outdoor environment is a real threat in today’s world (EmergencyNet NEWS 1995). The analysis of trace-level, vapourphase compounds in air requires thermal desorption (TD) to pre-concentrate the compounds before analysis by gas chromatography (GC), mass spectrometry (MS) or GCMS (Markes International.TDTS12). This paper describes the latest continuous on-line monitoring technology with sub-ppt detection limits and pumped tube sampling with off-line analysis for monitoring human exposure at even lower levels. Rapid and accurate continuous monitoring is required in the most sensitive civilian locations in order to minimise loss of life in the event of a terrorist attack. A novel, peltier-cooled, twinstaple sampling system is described which operates continually, with no blind spots, and enables near real time (NRT) analysis (cycle times <15 minutes) with sub-ppt detection limits. Performance examples are presented, including the analysis of free underivatised VX nerve agent, at low pg levels (Markes International Ltd.TDTS44).

5.7.14 A simple simulation model of building transient heat conduction for building environment evaluation

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Based on circuit principle, this paper presents a simple simulation model (3R2C model) of transient heat transfer through building envelope, which is applied to simulate and analyze the process of multilayer envelope transient heat transfer. A transfer matrix of a wall is deduced by Laplace transform on the basis of 3R2C model. The theoretical frequency characteristics of the wall are calculated. Via proper identification algorithm, the polynomial coefficients for the transfer matrix are estimated from the theoretical frequency characteristics. Then, the resistances and capacitances of the model are determined by an optimization algorithm, which makes polynomial s-transfer function based on the model equivalent to theoretical transcendental s-transfer function of the wall completely. Examples demonstrate that the 3R2C model is accurate, simple and efficient in calculating building transient heat transfer.

5.7.15 Analysis of energy consumption for office building using advanced BIN method

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Advanced BIN method is employed to simulate the energy use of an office building and the main factors which influence the annual energy consumption of buildings and their respective influencing degree are investigated. The result indicates that in office building, the main factors of affecting the energy consumption are the inside design temperature, people density, fresh air volume, indoor equipment and shading coefficient.

5.7.16 Management of indoor air quality in Canadian schools

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The way indoor air quality is being managed in Canadian schools is primarily reactive. Help and advice for schools facing IAQ problems is focused at the school building level where the funds and expertise are not always available. Success in solving and preventing indoor air quality problems varies. Indoor air quality management should be proactive and directed at the school system level. It is here that funds are allocated; plans for renovations are made; policy, budgets, and procedures for IAQ can be established; and people with the appropriate skills can be trained. It is with the school systems that the ultimate responsibility and liability for IAQ lies. To better manage IAQ in Canadian schools, an indoor air quality management system (IAQMS)
that is directed at school systems is proposed. It includes the management elements of: commitment and policy; planning; operational procedures; education; communication and reporting; and monitoring for continual improvement. These core elements of the management system have been adapted from the International Organization for Standardization (ISO) ‘Environmental Management Systems.’ A survey and a literature review were conducted to identify the unique requirements for managing the indoor environment. These were amalgamated into the core management elements. Potential benefits of an indoor air quality management system (IAQMS) include: reduced risk to human health and a better learning environment; increased awareness about IAQ impacts; better decision-making and management control; better cost control; improved relationships with members of the community; and decreased possibility of incidents resulting in legal action. The IAQMS can be adopted by school systems or can be modified (maintaining the basic core management elements) to suit any organisation that wishes to improve the way they manage IAQ.

5.7-17 Sustained strategies and tools response to the industrial and office sick building syndrome (SBS)
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The problem of SBS is an important question to be solved. This study has an interdisciplinary character and will be presented in a logical way and without separating the different problems. At the beginning of the paper a flow chart system methodology will be employed to show all the operations, which could result in SBS. Apart from showing the classic reaction to undesirable actions, this system reveals new possibilities for the use of sustained standard strategies and provides tools which can provide a degree of strengthening of the design of existing industrial and office information channels which are present in the system of architecture and which would solve the SBS problem. This paper includes a flow chart that represents the closest geographical environment of an ecological system and describes six different actions prompted by their environmental input which is compared to the environment of an ecological system and describes six different actions.

5.7-18 Validation of CFD for the flow around a computer simulated person in a mixing ventilated room
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This paper gives a summary of a detailed Computational Fluid Dynamics (CFD) study of the flow around a Computer Simulated Person (CSP) for the purpose of validation. This was conducted using an canonical building environment scenario of the mixing ventilation type and included verification against test data. The contribution of this work was identifying the necessary requirements of several computational aspects such as grid resolution, boundary conditions and turbulence models that are needed for the accurate CFD simulation of the Personal Micro-Environment (PME), i.e. the person’s breathing zone.

5.7-19 CFD analysis of the flow around a computer simulated person in a displacement ventilated room
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This paper gives a summary of a detailed Computational Fluid Dynamics (CFD) study of the flow around a Computer Simulated Person (CSP) in an otherwise empty displacement ventilated room. This study identifies the requirements of several computational aspects such as convergence criteria and grid resolution that are needed for accurate CFD simulations of the personal micro-environment. Two important flow structures, one in the thermal plume and another, the recirculating flow in the room, made it difficult to determine convergence; hence care must take when monitoring convergence. A grid study highlighted the influence of grid resolution on the recirculating flow path while showing a weaker influence on the thermal plume. Two RANS turbulence models, the standard k – ε with an advanced wall treatment and the ν2-f, predicted different behavior in both flow structures; however without experimental data the results could not be validated.

5.7-20 Study on the genotoxicity of PM2.5 in vivo
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In this study Wistar rats were used to explore the potential genotoxicity of fine particulate matter (PM2.5) by intratracheal instillation. Samples of PM2.5 were collected in Beijing and prepared suspension. Twenty female Wistar rats with approximately 180 g body weight were divided in five groups. Four doses of PM2.5 were 0.3 mg, 0.75 mg, 2 mg and 5 mg per 0.5 ml physiological saline respectively and saline was treated as the negative control. All rats were intratracheal instilled once a week and seven weeks later they were all sacrificed. The chromosomal damage was detected by traditional micronucleus test in sternum marrow cells of rats. DNA damage in lymphocytes of rats was examined by single cell gel electrophoresis (SCGE). The results showed that PM2.5 could cause chromosomal and DNA damage respectively in certain concentration. The study indicated that PM2.5 had potential genotoxicity in rats.

5.7-21 Home conditions of persons with self-reported multiple chemical sensitivity
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Indoor air-related health problems and Multiple Chemical Sensitivity (MCS) are well-known related disorders. Aim of the present study was to investigate home conditions of persons with self-reported MCS (sMCS) vs. controls. Therefore, dependence of questionnaire-obtained home conditions on sMCS and controls were analyzed. In contrast to the controls, the sMCS showed a longer ago home renovation, more use of air cleaning systems, lesser use of disinfectants, sanitary cleaners, universal cleaners, fabric softeners and repellents, more changes at home, more annoyance at home generally and particularly due to odors, as well as a feeling of decreased well-being at home. Observation in the differently distributed home conditions between sMCS and controls are mainly factors which are associated with an odorous effect component. In conclusion, the results fit in the olfactory hypothesis of MCS. Further research about the pathophysiology of MCS should focus on the role of the olfactory system including genetic polymorphisms.
5.7-22 Attentional deficiencies associated with low-level lead exposure
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Although lead exposure has been steadily decreasing, some still occurs in the metal processing industry, through wall paint and tap water. Studies on children showed neurobehavioural effects of low-level exposure, but little is known about chronic effects in adults. We investigated neurobehavioural effects of lead exposure in adult outpatients and controls at the Unit of Environmental Medicine (UEM), Aachen University Hospital, Aachen, Germany. Using a computerized test battery, we evaluated the attention functions alertness, visual scanning, divided attention, intermodal comparisons, incompatibility and flexibility. Lead blood levels ranged from 1–65.6 μg/l (mean: 22.2 ± 18.3 μg/l). Although neuropsychological test results of all patients were within the normal range, there were significant correlations between blood lead levels and speed of information processing (working memory). Further statistical analysis showed these effects to be independent of confounding variables (intelligence, personality traits, emotions). The results indicate that diminished working memory capabilities are associated with low blood lead levels.

5.7-23 Deserts: ultimate dumps or last frontiers?
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The paper traces some of the most common unsustainable practices of desert exploitation and shows how these cause environmental deterioration and adversely affect the health of large populations. It argues that unless alternative, sustainable planning and management are employed, deserts may well prove to be a nemesis for the next generations.

5.7-24 Evaluations of the comfort associated with breathing air with a 30% oxygen concentration: evaluations related to the degree of mental comfort
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This research studies changes in the degree of mental comfort associated with varying levels of oxygen in living environments. Oxygen-enriched air was supplied through an oxygen supply system fitted with an oxygen enrichment membrane. The degree of mental comfort was determined by analyzing the fluctuating rhythm of subjects’ brain wave cycles and through subjects’ subjective statements concerning alertness levels. Comfort was evaluated using the Krapelin Test. It compared stress levels when subjects breathed normal air and when they breathed oxygen-enriched air. When under the stress of the Krapelin Test, our outcomes showed improved test results for those subjects who breathed oxygen-enriched air compared to when they breathed normal air. Furthermore, levels of comfort were significantly increased after testing.

5.7-25 The effects on the human body of breathing air possessing 30% oxygen – effects on blood glucose levels, body weight/body fat ratios, visual acuity and stratum corneum renewal
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This research studies the physiological changes that occur when breathing oxygen-enriched air. Glucose levels, body weight, body fat ratios and visual acuity were selected as evaluation items. Glucose levels were significantly lowered in 3 out of 9 test subjects after they breathed oxygen-enriched air. 5 out of 14 subjects exhibited statistically significant decreases in body weight and body fat ratios. Although improvements in visual acuity were observed in 3 out of 13 subjects, the differences recorded were not considered to be statistically significant. When breathing oxygen-enriched air, 4 out of 10 subjects exhibited an improvement in stratum corneum renewal speed (turnover).

The 8OH-dG content in urine was measured to observe the impact of oxidative stress. For a period of 24 hours commencing immediately after breathing oxygen-enriched air, measurement of 8OH-dG in the urine, an indicator of active oxygen generation, did not exhibit any significant increases among test subjects.

5.7-26 Environmental health study of Swedish children
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To gather information about children’s environmental health situation in Sweden a national questionnaire study was initiated. The questions address various aspects of indoor- and outdoor environment, health conditions, diseases, allergic conditions, and if perceived symptoms are related to specific environments or situations. Aim To compile the present knowledge about risk factors in the physical environment that is considered to be important in a child’s health perspective and provide a basis for priorities and future decisions within the field of environment and health. Result Data showed that asthma and atopic diseases as well as early recurrent infections in infants are more commonly reported among children living in homes with signs of defective indoor environment. Conclusion and implications The present study contributes important information on children’s health and generates information about the different settings where children spend their time – their home, school, and day-care centuries.
5.7-27 Sorption hysteresis and scanning in a flooring screed – implications for moisture induced degradation
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Sorption isotherms [moisture content as a function of relative humidity (RH) at equilibrium] are an important tool in designing buildings to limit moisture related problems. Normally only a single sorption curve is used so that each moisture content uniquely corresponds to one RH. Sometimes two curves are used, one curve for absorption and one for desorption, as it is well known that sorption has a strong hysteresis for most materials. However, in most situations, materials do not simply follow either absorption or desorption, but will follow scanning curves within the hysteresis envelope.

In this paper we discuss data on sorption hysteresis and scanning for a cement based flooring material. These data show that the RH-increase will be many times higher when the flooring material absorbs moisture from, e.g., water based adhesives, than would have been predicted by a model without scanning. Implications for expressing critical moisture levels are discussed.

5.7-28 A new method to evaluate the compability of floor constructions
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Secondary emissions from flooring constructions lower indoor air quality and are often related to the sick building syndrome. As floor constructions are often complex constructions including several different materials that interact with each other, it is important to be able to investigate the function of complete flooring systems and not just single components. This paper describes a method which makes it possible to investigate the function of a complete flooring system regarding secondary emissions under different moisture loads. It is not only levels of emissions that can be investigated, but also critical values of moisture loads for complete flooring constructions. Measurement results from a construction consisting of PVC flooring bonded to concrete show strongly increasing levels of emissions at moisture loads exceeding 85% RH.

5.7-29 Investigation and analysis on civil building energy consumption and thermal environment in Changsha
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Energy consumption and thermal environment parameters of some typical commercial buildings and residential buildings located in Changsha of Hunan Province are surveyed and tested. The energy composition and its annual change regularity are illustrated and the relationship between air-conditioning energy consumption and the percent of unsatisfied people in commercial buildings are analyzed. Energy consumption of residential buildings and its main influencing factors are discussed. Based on the actual surveyed results, some energy-saving factors that should be considered are put forward.

5.7-30 Exposure assessment of chemical sensitivity patients
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We measured the personal exposure levels of chemical sensitivity (CS) patients. The objective of the study is to understand the variations in the patients’ personal exposure levels and to investigate the relationship between exposure levels and the recuperation of CS symptoms. Subjects were all female CS patients. This study examined aldehydes and volatile organic compounds (VOCs). Personal exposure levels and indoor and outdoor concentrations were measured over one week periods nearly every month since autumn 2000. Measurements continued for at least six months. Personal exposure levels were nearly identical to the indoor concentrations, and the levels were less than Japan’s indoor air guideline. Personal exposure levels did not decrease over the measurement periods while formaldehyde levels increased from winter to summer. Severity scores decreased and no positive relationship was observed between the exposure levels and the recuperation of CS symptoms.

5.7-31 Case study of health problems related to dampness in residential buildings in cold climatic regions of Japan
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In 2002, the indoor environment and occupant health of approximately 800 residential buildings were investigated by a questionnaire. As a result, the actual conditions of the indoor thermal environment and the indoor air quality have been clarified, and several problems related to dampness in buildings, have been grasped. To recognize these problems reported by occupants form the viewpoint of the relationship between occupant health problems and indoor air pollution related to dampness, factors such as airborne fungi and dust mites were measured. The buildings investigated were selected from among respondents to a previous questionnaire survey, which revealed problems related to vapor condensation. The results indicated that in houses suffering from certain occupant health problems, the concentration of airborne fungi and the number of mites present tended to be large. However, no clear correlation between health problems and indoor air pollution related to dampness was found, and further investigation is required.
5.7-32 Immunological effects on Wistar rats after chronic exposure to PM$_{2.5}$

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PM$_{2.5}$ has been shown to cause many health issues. These effects have been considered to be a consequence of inflammation and impairment of defense function. Female Wistar rats exposed to PM$_{2.5}$ at concentrations of 0.3 mg, 0.75 mg, 2 mg per 0.2 ml saline respectively. saline and cyclophosphamide (CP) were used as the negative and the positive control. The rats were sacrificed at 1, 3, 6 months posttreatment. The results showed that long-term exposure to PM$_{2.5}$ can induce the dose-effect TNF-$\alpha$ expression at first month. At the 3 and 6 month, the mRNA expression of TNF-$\alpha$ was mildly inhibited by PM$_{2.5}$. The expression level of IL-6 was reduced with the exposure time prolonged, but the expression level in high-dose was more significant than that in low-dose. PM$_{2.5}$ also impaired phagocytic activity of the AM. It is hypothesized that the dysfunction of AM and toxic material of PM$_{2.5}$ might contribute to the response of lung. In conclusion, it is possible that PM$_{2.5}$ play an important role during the development of chronic lung injury and could damage the defense of lung.

5.7-33 Synergistic effects of exposure to noise, heat stress and indoor air pollution on mice neural behaviors

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The indoor environment is always complex for people to analyze and understand, because it includes indoor air pollution, thermal comfort, acoustic environment and lighting environment, which make common influence on various human bodies and also the neural system. The paper aims to investigate neural symptoms of mice when they are exposed simultaneously to different levels of noise, heat stress and air pollution with various combinations. The experiment was accomplished in static envenoming chambers. The neural behavior test included spontaneous activity, darkness dodging and water maze. The neural behaviors of mice are observed under different artificial circumstances. The data received from all the tests are statistically calculated and processed by SPSS, a statistic software. A synergistic effect model is used to measure the strength of the influence from the individual environmental factors and their different combination effect. It is showed that the synergistic effect exists among the all three components of the indoor environment.

5.7-34 A new indoor air quality assessment system and its software tool

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This article describes the features and operation of a new indoor air quality assessment system and its software tool named SRIBS-IAQ. The assessment system and its software tool were used in a case study to establish its practicality and performance. This assessment system is unique in the sense that it employs an optimization model called the grey model. We establish a set of Air Quality Objectives (AQOs) among which were five compulsive: HCHO, TVOC, C$_6$H$_6$, NH$_3$ and radon. The others are optional: O$_3$, CO$_2$, CO, NO$_2$, PM$_{2.5}$, microbe. It also includes the assessment of comprehensive environmental impacts such as combined toxicity of HCHO and TVOC and the database of Shanghai local meteorology, building materials and construction properties. Based on the different functional building, resident and office, this new indoor air quality assessment system use some scientific models to evaluate the main influence factors and its impact on human health, comfort and productivity in indoor environment, it also to predict the concentration and exposure rules in certain times. And then, in order to reflect the result directly, we use a positive score for this evaluation system. The application of a weighting system of the score was also afforded. Some scientific and reasonable control and improve measurements are put forwarded.

5.7-35 School environment and children health impact in developing country

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Background Developing country like Nepal has poor health status in school students.

Objective To know and evaluate the indoor environmental condition of government and private-schools.

Methods A cross sectional studied of representative samples of 35 schools of selected region of Nepal including government and private schools. Onsite observation and health check up & interview with students and teachers were done. Specific scores was given in each criteria. The data were analysed and edited in EPI info program.

Results The results shows that 89% of government school and 45% of private-schools have poor environmental condition and 69% of government schools students are suffering from environmental-health problem while only 22% of private school student are suffering from some kind of diseases. Government-school don’t have the standard classroom, adequate sports facility, safe drinking water, light and ventilation in comparison with private schools.

Conclusions We conclude that the main causes are poor socio-economic status, illiteracy of parents, negligence, hard workhouse for children, diseases, malnutrition, incomplete immunisation and lack of health education. The poor environment condition includes crowded students in a classroom, poor ventilation, shortage of clean drinking water, untidy clothes of students, poor nutrition and lack of greenery in the school area, school near by road, air pollution and lack of environmental awareness among teachers and parents. The government schools have limited budget, resources with compared to private schools and most of the lower and lower middle class family children are studying in government schools which covers nation 82% of total students.

Recommendation The government should allocate the special budget to the government schools and it should be utilised from the available resources such as good ventilation, limited student in a class, awareness among teachers and parents. Last but not the least, this type of programs are helpful to prevent from environmental health hazards also.
5.7-36 Self reported health conditions, total IgE, specific mold-related IgE and precipitating IgE antibodies among teachers and pupils in a water-damaged school with known mold growth and in a school without these problems – a controlled intervention study

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Background An increasing amount of people (teachers and pupils) working in water damaged workplaces are referred from general practitioners and other medical specialists to the departments of occupational medicine in Denmark. They have developed work related common symptoms (headache, dizziness and tiredness) and skin/mucous membranes problems. A few have documented problems from the respiratory system. Unfortunately our present knowledge regarding health effects in relation to exposure to water damage moulds are insufficient and there are a lot of unanswered questions for example: the effects on the immune system (total IgE, specific IgE and IgG-antibodies and the reversibility of these values, the incidence of allergy, the effect on lung function, respiratory hypersensitivity and the reversibility of these possible effects etc. One of the major problems in many of the earlier controlled epidemiology studies in this field has been problems achieving sure and essential contract in exposure. Because of a documented severe water damage with verified growth of typical building moisture-related moulds (Stachybotrys chartarum, Cladosporium sphaerospermum, Aspergillus versicolor, Penicillium chrysogenum, and Trichoderma viride) a big school in the south of Jutland in the town of Åbenrå in Denmark in spring 2002 was going to be renovated. By comparing objective and subjective health conditions in the teachers and pupils from this school with a similar documented dry control school we have a chance to get new information about the occurrence of health problems by exposure to moulds in school building. By a later comparison of possible objective and self reported health effects in teachers in both the index and the control school 1 year after the end of intervention (the renovation of the water damaged school) in spring 2004 we could investigate the effects of the improvements of the index school building. Some of the purposes of this controlled interventions study are: To collect new information on the connection between staying in a documented water- and mould damaged building and the teachers’ and pupils’ objective and self reported health conditions and to investigate the reversibility of a possible influence. To investigate the correlation between raised concentrations of specific IgE- and to examine a probable connection between raised antibody concentrations and objective and subjective health effects. To test the value of the precipitating IgG-antibodies as biological markers of contact to mouldy materials and to examine a probable connection between raised antibody concentrations and objectives/subjective health effects and to investigate the reversibility of a possible influence.

Material Index school:
Teachers Spring 2002 56 teachers (87%), 48 of these teachers participated in spring 2004.
Pupils in the 6 and 7 class Spring 2002 87 pupils (87%) and 42 of these pupils (now in 8. and 9. class) participated in spring 2004.

Control school:
Teachers Spring 2002 59 teachers (79%), 35 of these teachers participated in spring 2004.
Pupils in the 6 and 7 class Spring 2002 110 pupils (80%), 66 of these pupils (now in 8. and 9. class) participated in spring 2004.

Method 1) Investigation of the building conditions of the school by skilled building constructions experts

The building examination program included evaluation of visible/hidden moisture, cultivation of samples for mould, mycometer – test (test for mould enzymes), qualitative (type/numbers of mold colonies, mites, cat and dog allergens) and quantitative dust measurements from air and deposits.

2) Investigation of the teacher and pupil population (the index and the control school) before and after the intervention

Validated questionnaire question regarding common health and skin and mucous membrane problems, lung symptoms, allergies, tobacco, psychological work environment, leisure-time and housing (conditions) for example water damages at home and more.

Blood samples total IgE, white blood count, eosinophils, C-reactive protein, precipitating IgG- and specific IgE-antibodies against Stachybotrys chartarum, Cladosporium sphaerospermum, Aspergillus versicolor, Penicillium chrysogenum, Trichoderma viride (the dominating moulds in the Index school). In addition analyses for allergens to cat, dog and dust mites.

Lung function measurement of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1) and methacholin provocation ad modum Yan.

5.7-37 Study on the security technique for the metro air environment under the nuclear biological or chemical terror

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According to the analysis of the new international terrorism development trend, the urgency and necessity of the defense and fight terror system and policy are presented. In this paper, the technical measure, index, feasible running pattern and safety strategy, which are necessary to ensure the city metro air environment, are studied. It will provide the guidance for the metro fighting against the nuclear biological or chemical terror raid.

5.7-38 IAQ in schools in South Korea: the importance of awareness and a coordinated approach

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Air quality has an impact on health. Children are more vulnerable than adults. Because children are likely to spend at least a third of the day in school, air quality in schools and how it affects children’ health, comfort and productivity has been attracting an increasing level of attention. This paper presents a summary of a literature review on this subject in S. Korean with the aim of contributing to identify general trends emerging from studies conducted worldwide. A specific focus of this paper is on identifying factors influencing the relationship between climate, surroundings, school characteristics, and Korean children’ health. The conclusion is that, like in many other countries, despite the multiplicity of factors that impact the relationship IAQ-children’ health, there is a clear need for increasing awareness among policy makers to enable a health focused comprehensive and coordinated approach to design of new schools and/or renovation of existing ones.
5.7-39 Objective measuring methods for measuring effects of low dose exposures on humans indoors

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Objective, physiological methods used in studies of low-dose exposures to air pollutants occurring indoors are summarized. These methods include measurements on the upper respiratory tracts, as well as on the eyes (e.g. rhinometry, rhinostereometry, break-up-time, epithelial damage, etc.). In addition four new methods were examined in laboratory experiments with human subjects exposed to clean air and air polluted by emissions from typical building materials and bioafluen-
tants. Near infrared spectroscopy measuring the cerebral blood flow was tested as a potential indicator of mental effort and fatigue. Voice record-
ing was tested as a potential indicator of fatigue. Concentration of end
tidal CO₂ was tested as an indicator of changes in breathing pattern when indoor air quality is reduced, possibly associated with headache. Concentration of NO in exhaled air and nasal cavities was tested as an indicator of sub-clinical inflammation in the respiratory tracts due to indoor exposures. The aim of these studies was to find methods that can be useful in diagnosing SBS symptoms objectively and which can relate health effects with poor indoor air quality.

5.7-40 IAQ effects on breathing may be what cause

SBS symptoms and reduce office work performance

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It has been shown that used carpets, supply air filters or PCs cause sub-
jects to report an increased intensity of such symptoms as headache and
difficulty in concentrating, and to perform office tasks less effectively.
An experiment was conducted to test the hypothesis that these effects might be caused by involuntary changes in breathing behaviour, leading to slightly raised levels of CO₂ in the blood, as obstructed breathing that greatly increases the CO₂ concentration in the blood is known to cause severe headache. Twenty four female subjects aged 19–30 were exposed in pairs to each of three indoor air quality conditions: 1) Outdoor air supply rate 20 L/s/p in a low-polluting room; 2) A raised bioeffluent level – 3 L/s/p in the same room; 3) Polluted air – 3 L/s/p with a used carpet concealed in the same room. Subjects encountered the 3 conditions in balanced order, always at the same time of day and on the same weekday, for 3 hours. They performed a number of office tasks on a computer throughout each exposure and marked visual-
 analogue scales to indicate SBS symptom intensity and perceived air quality (PAQ). Portable vital-signs equipment was used to monitor End-Tidal CO₂ as an estimate of CO₂ levels in the blood, respiration rate, pulse rate and blood oxygenation. PAQ was significantly lower at
3 L/s/p than at 20 L/s/p, but was unaffected by the presence of the used carpet. The paper will report the results of further analysis of all the data.

5.7-41 Is quantitative risk assessment method appropriate for indoor exposure health impact evaluation?

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Context The health risk assessment method developed by the Amer-
ican National Research Council has proved to be a very useful tool to
identify and quantify public environmental health risks. As far as the
indoor air quality (IAQ) is concerned, scientific knowledge is growing:
more and more pollutants (chemical or biological, gaseous or particu-
late, . . .) are measured allowing a more precise and integrated human
exposure characterisation. Besides few works at this time, in particu-
lar in France, are dedicated to quantify health impacts linked with IAQ
pollutant exposures.

Objective A first exercise has been done considering formaldehyde daily exposure (occupational exposure is excluded). This chemical agent is thus measured in any indoor microenvironment because of very numerous emission sources: plywood, building materials, cosmetics, . . . Indoor concentrations may be quite significant, in schools for example. Moreover formaldehyde health effects are rather well known: formaldehyde is a respiratory irritant, is assumed to worsen asthma by allergic people especially by children and is classified as a human carcinogen by the International Agency for Research on Cancer (Group 1 since June 2004).

Method Reference concentrations and excess unit risk or minimum risk level or reference level for chronic formaldehyde inhalation were respectively found in international toxicological databases (USEPA/IRIS, ATSDR, OEHHHA). Ingestion or cutaneous exposures are considered negligible. Besides, outdoor, at home and at school exposure levels were collected. French values were used, in particular those from the French Observatory for IAQ preliminary survey con-
ducted in 2001. Since levels in French transports were not available, commuting contribution to total exposure was neglected in this first approach. On the basis of time activity patterns for children and adults, total inhalated concentration (IC) was calculated for different age groups.

Results Considering the ATSDR minimum risk level for nasal epite-
lium lesions linked with chronic formaldehyde inhalation (10µg/cum),
Hazard Quotient (HQ) are above 1. On the other hand, the excess indi-
vidual risk for whole life is about 10⁻⁶ (nasopharynx cancer), i.e. higher
than the common levels for acceptable risk (10⁻⁷/10⁻⁸). Perspectives: This study has shown the feasibility of the method. However these first results can’t be roughly used and in any case extrapolated to the French general population. Results would be considered reliable on condition that exposure would be statistically representative and determined in all microenvironments. That’s why this work consists a very first step that will be more completely developed based on the French national survey in process in more than 700 homes. Comparison with nasopharyn-
x cancer prevalence will allow to quantify the real indoor exposure contribution health impact. Besides the similar work will be performed for benzene.

5.7-42 Moisture balance, housing, health performance

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Problem Moisture problems in dwellings are widespread, yet there is no clear understanding of the moisture balance: the moisture emis-
sion of different sources, the effect of transport to different rooms, the absorption and re-entrainment processes and the removal of moisture by drying, cleaning and ventilation.

Objective The objective is to study the moisture sources, the peak shaving and removal mechanisms and the resulting humidity levels in different rooms. A tool will give insight in the moisture concentration in different types of dwellings and for different seasons. Outdoor conditions are included: air temperature and humidity. The balance study will be located in The Netherlands, a country with a moderate and moist sea climate.

Method Experimental data is being collected about the moisture pro-
duction related to the occupancy of the house: cooking, washing and bathing, laundry drying, keeping pets, use of flue-less gas heaters. Also, data about the emission from damp crawlspaces, from capillary mois-
ture transport and the absorption of moisture in surface layers is col-
lected. A data set of technical features and occupancy patterns of 333
dwellings provides information on the conditions that create condensation and mould problems.

**Results** The data set is used for the development of a practical balance sheet, that will be transformed into a tool that helps to identify conditions with high risk of mould growth and high house dust mite population growth. The tool is placed in the context of health impact assessment of individual dwellings. The threshold levels will be linked to the problem situations found in the dataset.

**Conclusions** The moisture balance sheet is expected to give insight in the moisture producing and removal mechanisms in dwellings, its relation to occupancy patterns and life style and its effect on the health performance of housing.

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**5.7-43 Health risk assessment of indoor air pollution in Lao PDR**

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The Ministry of Health of the Lao PDR with the support of the World Health Organization undertook to investigate the effect of indoor air pollution on human health. Exposure to indoor air pollution is considered to be high risk factors in Lao PDR since in over 90% of households cooking is conducted using un-vented stoves with wood being the main fuel. The design of a significant proportion of the dwellings is such that the cooking area is located inside the house, and the sleeping areas often in an immediate vicinity to the stove used for cooking and heating. Two types of studies are being initiated: (i) as the first stage a Cross Sectional study will be conducted focused on women and children, with the main aim to determine the prevalence of health outcomes related to respiratory illness and symptoms and cardiovascular disease in household residents, and their association with housing factors. The study will be conducted in three Provinces in Lao PDR, including Vientiane Province as well as one Province in the south and one in the north of the country; and (ii) as the second stage, a Case Control study, focused on respiratory disease in children will be conducted in Vientiane Province. This stage will include measurements of PM10, CO and NO2 concentration in the houses of case and control children. This paper reports on the design of the two studies and the preliminary findings from the cross sectional stage of the study.