Assessment and management of risk factors and adverse effects in the modern office environment

Chairs of the symposium

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Aim of the symposium

There is an increasingly request to assess the risk and monitor the health status of workers in modern office buildings. This symposia is promoted by the Scientific Committee on Indoor Air Quality and Health of the International Commission on Occupational Health (ICOH) and the topic will be discussed by researchers of projects performed in modern offices.

Presentations

Volatile organic compounds in office buildings: identification of major sources and intervention study to reduce indoor concentrations - Corinne Mandin, CSTB, France
The first presentation was targeted to the results from the OFFICAIR project field campaigns. Firstly, thirty-seven “modern” office buildings participated in a summer monitoring campaign (2012), and thirty-five among them participated in a winter campaign (2012-2013). One of the objectives was to have an overview on IAQ in office buildings built or completely refurbished after 2001. Four rooms were investigated per building. The target pollutants were twelve volatile organic compounds, seven aldehydes, ozone, nitrogen dioxide and particulate matter with aerodynamic diameter less than 2.5 µm (PM2.5). Regarding VOCs and aldehydes, compared to other studies in office buildings, the benzene, toluene, ethylbenzene, and xylene concentrations were lower in OFFICAIR buildings, while the α-pinene and d-limonene concentrations were higher, and the aldehyde concentrations were of the same order of magnitude. The OFFICAIR project provides a reference dataset for indoor concentrations obtained from 5-day sampling in 37 modern office buildings in 8 European countries. It also provides knowledge about the spatial and temporal variabilities of indoor concentrations for some selected pollutants in offices.
Secondly, the intervention study carried out in 9 office buildings from 6 countries in the frame of OFFICAIR was presented. This intervention study has been performed with the aim of assessing the benefit on health and IAQ of intervention strategies related to IAQ. The intervention consisted in the replacement of floor cleaning products with a low volatile organic compounds (VOCs) emitting one. To check the efficiency of the change of the floor cleaning product regarding irritative VOC emissions, the regular product used in each participating building was tested beforehand in emission test chambers. The measurements were performed before the intervention in two areas per building: the intervention area and the control/sham area. Then, the measurements were repeated in the same areas after 5 weeks of use of the alternative product in the intervention area. For the first time, the contribution of cleaning product emissions on IAQ in office buildings is shown: for five aldehydes, the concentrations after the intervention were significantly lower in the intervention room but not in the control room, and the difference in indoor concentrations between the 2 rooms was significantly different after the intervention compared to before. The influence of the intervention was not
observed on VOCs. Regarding particles, no influence of the intervention was shown; other determinants of particle indoor concentrations are predominant in office buildings.

**Health effects of Indoor Air Quality in European modern office buildings - Paolo Carrer, University of Milan, Italy**

The second presentation was targeted to the health results from the OFFICAIR project field campaigns.

Aims: to evaluate the present situation about complaints and symptoms known to be related to IAQ in modern offices across Europe and to assess the correlation of self-reported complaints and symptoms related to IAQ with objective health effects measurements; to evaluate the health effects of selected and prioritised IA pollutants, including reaction products, e.g. oxidation product, under different conditions in modern office buildings across Europe, taking into account the role of stress; to perform health risk assessment of targeted indoor air pollutants; to evaluate the benefits on health of intervention strategies on IAQ.

The main results were: frequent negative environmental perceptions (>30%) for air too dry, air stuffy, air smelly, noise from inside building in modern office buildings; frequent eye symptoms (>20%); environmental perceptions associated with mold growth, acoustical solutions, cleaning activities; symptoms associated with number of occupants, lack of operable windows, presence of carpet, and cleaning activities. Role of cleaning activities on IAQ need to be investigated. Office workers with high efforts and low rewards had a higher risk of building related symptoms suggesting a complex effects of psychosocial factors on BRSs: impact on workers’ perceptions of health or increased susceptibility to environmental exposures ?.

**Physicochemical risk factors for building-related symptoms: thermal conditions and combined exposures to indoor air pollutants - Kenichi Azuma, Kinki University Faculty of Medicine, Japan**

Building-related symptoms (BRSs) have emerged as an occupational and environmental health issue since the early 1970s. Although the Building Sanitation Management Standards have been enforced since 1970 in Japan, excess ratios against the temperature, relative humidity, and carbon dioxide standards have increased in recent decades. A three phase studies has been conducted. The phase 1 study was a nationwide cross-sectional questionnaire survey to estimate the prevalence of BRSs and related risk factors during winter and summer. The results were presented at the Indoor Air 2014 conference. In the phase 2 study, we selected office buildings that had higher and lower prevalence of BRSs from the phase 1 study and conducted a cross-sectional study to examine the association between the indoor air quality (thermal conditions and pollutants) and BRSs. The surveys were conducted in 11 offices with 107 employees during winter and in 13 offices with 207 employees during summer. A part of the results was presented at the Healthy Buildings Europe 2015 conference. In this presentation, we report the detailed analytical results on the physicochemical risk factors for BRSs from the phase 2 study.

Multivariate analyses revealed that upper respiratory symptoms were significantly associated with temperature, relative humidity, and particles during winter. Formaldehyde, ethylbenzene, and total volatile organic compound were also associated with the symptoms. Acetaldehyde, toluene, xylene, and tetradecane were associated with the symptoms. These associations were observed in indoor air concentrations lower than those in the Japanese indoor air quality guidelines. These results suggest the importance of evaluating the combined risks from pollutants of similar health effects and the future strategy for reducing the risks. As a phase 3 study, we have been conducting a longitudinal study (questionnaire, measured data) since 2014. We will report on the progress as well as on a part of the results.

**Why eye symptoms in aircraft and offices - Peder Wolkoff, National Research Centre for the Working Environment, Denmark**
Eye irritation, e.g. dry or tired eyes, is generally among top-2 or 3 reported symptoms in aircraft and offices. Visually demanding workplaces increase continuously and so does the average age of the workforce. To be in a position to interpret the generally high prevalence of eye symptoms in indoor environments, a multidisciplinary and integrated approach has been carried out that involves the external eye physiology (separate from internal eye effects), external eye diseases, and risk factors that destabilize the precorneal tear film, which in the end results in hyperosmolarity from water loss and inflammatory reactions leading to the symptoms.

A substantial fraction of the general population suffers from (sometimes unrecognized) mild eye diseases that will add to the reported prevalence of eye symptoms in office-like environments. In addition, a number of environmental, occupational and personal risk factors may further contribute to the high prevalence of eye symptoms. Several of these risk factors may act in a concerted and exacerbating manner.

Two major important risk factors that have been identified are extended exposure to low relative humidity and intense visually and highly demanding cognitive computer work with a video display unit. Indoor air pollution, per se, does not appear to be a salient contributor of eye symptoms with the exception of special scenarios with high production of formaldehyde or acrolein. On the other hand, combustion products, e.g. derived from high traffic density may be important, thus contributing to destabilization of the precorneal tear film during both commuting and during work.

**Indoor air quality audit management in modern office buildings - John Bartzis, University of West Macedonia, Kozani, Greece**

Building audits are performed for assessment and possible improvements on indoor air quality, micro-climatic conditions and perceived air quality and comfort. Audits are usually performed through checklists, questionnaires and measurements. There are several issues that need to be addressed in relevant office and office buildings audits. Various interventions are discussed here coming from the experience of the OFFICAIR Project.

The Indoor Environment Quality depends on several factors such as infiltration of outdoor stressors, indoor stressor sources and mitigation measures, ventilation patterns, heating/cooling conditions and humidity level. Building location, orientation and design plays also an important role since these factors define the degree of influence of the harmful outdoor stressors, the ventilation pattern, the building energy budget, the indoor lighting conditions etc.

Concerning outdoor stressors impact, the defining factors are: the background level of the outdoor air chemicals, the nearby (e.g. <100m) potential sources of outdoor air pollution, noise, contamination of the mechanical ventilation system, radon affected soils, solar radiation and local meteorological conditions.

Concerning indoor stressors impact, important defining factors are: the chemical emissions of building material, the chemical and PM emissions from consumer products use (e.g. cleaners, office equipment), mold, bacteria build-up and noise generation by devices or/and occupants.

The important effort is to try to reduce the indoor air pollutant sources. By knowing which building materials, furnishings and other products contain and/or emit certain pollutants, decisions can be made to avoid the use of some products and replace them with low emission building materials and furniture. Choose appropriate materials before starting renovation or maintenance work. Try to limit exposure to building materials that contain substances, which may constitute a health risk. Check whether low emission emulsion paint (e.g. water-based paint) can be used instead of paints based on organic solvents. Following renovation, increased levels of VOCs can generally be temporarily measured in the indoor air. It is recommended to wait some few days before occupying the building.

Concerning cleaners, choose less emitting cleaning products (marked with an eco-label). There are many environmentally friendly cleaning products that can be used. Organize cleaning in each location in the office building at the end of each working day, rather than just before the start of the
day. Maintain your working environment clean and report any notice of dampness and mold problems.

Concerning the use of consumer products, limit exposure to consumer products that contain substances linked to asthma or other respiratory diseases. Choose appropriate low emitting decoration materials and consumer products. Limit or avoid the use of air fresheners indoors.

The printing electronic equipment can be a major source of particulate matter. Prefer to place the printers and photocopiers in separate rooms rather than having them inside the office. Try to work away from any printing electronic equipment. Use the printers and photocopiers only when this is necessary.

Proper ventilation is, after source control, key to ensuring comfort on warm days, and reducing concentrations of polluting contaminants indoors, such as particulate matter, VOCs, CO2, etc.

HVAC systems may be contaminated (e.g. mold build up in duct lining or bacteria on coil or filters). Regular maintenance and duct sealing can help minimize these problems. Natural ventilation of an office building can be seen as an effective means to dilute indoor air pollutants, provided the outdoor air is clean and for as long as the outside weather conditions allow it. The use of a combination of natural and mechanical ventilation can ensure efficient use of energy.

IAQ can be improved enormously by educating the building occupants and cleaning staff about its importance for health and productivity. This requires structured awareness raising—that is, a mechanism that is routinely repeated over a certain period of time rather than individual events. Education on cleaning, good hygiene practices, windows opening and use of consumer friendly individual building products can influence behavior and lead to improvements in health and comfort. Smoking must be definitely banned.

**Discussions and Conclusions from the session**

Modern offices are created with the use of new components, materials, equipments and other consumer products, as well as new energy strategies (lightning, heating, cooling and ventilation) are implemented. A general agreement was about the variety of chemical, microclimatic, physical, biological, ergonomic and psychosocial hazards that can be present in these environments with a potentially high and diversified impact on the office workers health and comfort. Growing concern has been given to the pollutants that may be emitted from office equipment and cleaning products (ozone, primary VOCs and particles) and about reactive indoor air chemistry.

In modern office buildings an integrated team approach and management is recommended for periodical risk assessment and specific indoor problem solving, through an integration of building assessment, questionnaire survey, and environmental measurements. Psychosocial environment should also be considered in order to provide a healthy work environment.