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Health hazards in the office: Disease risks by indoor air

Abstract

Office workers may under bad conditions be potentially exposed to a variety of chemical, physical and biological factors. Generally, the exposure levels in offices are low as compared to workplace threshold limit values. However, there is little knowledge available about the health effects of these exposures that are mostly mixed exposures. The main exposures in indoor air originating from different sources and their potential effects on office workers are summarised in this paper. Occupational safety and health efforts are aiming at preventing and reducing potential risk factors.

1 Introduction

Even today, office workplaces may still present a large number of potentially health-impairing exposure risks. In particular, long-time exposures and potential additive or cumulative impacts may give rise to diverse symptoms or illnesses.

A definite correlation between the diverse causes and effects is not always easy to establish. Health effects emerging in the form of unspecific symptoms are commonly referred to as syndromes today. The purpose of this paper is to summarize the various exposures that may potentially occur in an office environment, as well as the associated symptoms, syndromes or illnesses. Given the very extensive nature of the subject, only airborne exposures shall be considered here. Moreover, only the most frequently reported health effects that may be incurred in an office workplace shall be described.

2 Potential risk factors in the office

In office workplaces one can identify various exposures which may, on principle, pose health risks to an employee. The risk factors most frequently cited in the literature are insufficient fresh air, defective air ventilation equipment, tobacco smoke, or evaporative emissions from contaminated building materials, paints, or furnishings such as wallpaper or carpets [1 to 7]. A systematic look at the potential exposures that may be present in office environments yields four groups, viz., physical, chemical and biological exposures, and psychosocial factors. The main potential risk factors in the office which have been identified in the scientific discussion are summarized in **Table 1** (see page 2).

Table 1:
Potential risk factors at an office workplace (selection).

Risk factor group	Risk factors	Examples
Physical	Indoor climate and ventilation	Temperature, air humidity, draft air, air change rate
	Noise	Frequent use of telephones in over-occupied offices
	Ergonomic problems	Unsuitable chairs, uncomfortable posture at computer (VDT) workplaces
	Lighting	Inadequate lighting, glare from computer screens
	Electric hazards	Electrical equipment, defective wiring
	Ionizing radiation	Radon
	Dusts, particles, fibres	High dust loads due to carpeting, asbestos
	Unfavourable general setup due to building situation, furnishings, office equipment/supplies	Slips, trips and falls due to smooth floors or stairs, slippery paper (cutting injuries)
Chemical	Hazardous substances, odours	Formaldehyde, ozone, etc.
Biological	Microorganisms, animal allergens	Mould fungi, house dust mites
Psychosocial	Stress	Time pressures, work overload
	Mobbing	Reduced communication

The present paper merely considers illness risks which may be attributable to indoor air quality. These risk factors will usually be of a chemical, biological and physical nature.

3 Potential illnesses in the office

Illnesses with the highest incidence are those affecting the respiratory tract, eyes and skin [1 to 11]. Allergies are particularly relevant in this context. Since it is common for several illness symptoms to occur simultaneously, the general term „syndrome“ is in use. One typical example is sick building syndrome (SBS), which is characterized by irritations of the eyes, the respiratory tract and skin [5; 12 to 13]. The symptoms constituting SBS were defined by the World Health Organization (WHO) in 1983 and have remained valid to this day:

- eye, nose or throat irritation;
- sensation of dry mucous membranes or skin;
- erythema (inflammatory skin rash);
- fatigue, headaches;
- increased frequency of respiratory tract infections and coughs;
- hoarseness, itching and unspecific hypersensitivity reactions;
- nausea, dizziness.

SBS is deemed to be present when the majority of occupants in a given building exhibits one or more of these symptoms and their complaints subside markedly a few hours after leaving the building [14].

The presumed cause of SBS is long-time exposure to low doses of potentially toxic substances. Individuals suffering from this syndrome respond to low concentrations of diverse “everyday” contaminant substances by developing unspecific symptoms which affect multiple organ systems, although clinical examinations and allergologic tests will typically yield no diagnosis. This illness pattern is also widely referred to as “building-related health complaints“ (BRC or BRHC), “indoor air quality complaints“ (IAQ complaints), “building-related symptoms“ (BRS) or “building-related illness syndrome“ (BRIS). The multitude of terms employed reflects the unspecific character of the phenomenon. It always occurs as an entire complex of unspecific symptoms. The terms “idiopathic environmental intolerance (IEI)” and “multiple chemical sensitivity (MCS)“ are likewise encountered in this context, but these may also relate to non-indoor-air environments and must therefore be considered broader in scope. The term “building-related illness (BRI)“, on the other hand, is used with reference to a specific disorder related directly to indoor air quality.

In analyzing the causes, one challenge lies in the complex cause-effect relationship. The quality of indoor office air is a function of numerous factors, but the criteria for quality assessment are unclear and the sources of the complaints cannot be clearly delimited from each other. Nevertheless, in the case of pronounced health complaints, the potential causes need to be investigated. For the assessment of indoor workplaces, a large number of procedural recommendations facilitating the identification of potential exposures is available [1]. The key exposures which may occur in this environment, as well as the associated specific health impacts, are summarized in **Table 2** (see page 4). It should be borne in mind here that most of these expositions are in a very low-dose range, and that such low concentrations will not, as a rule, suffice to trigger any specific illness.

As regards the exposures attributable to office equipment, research findings are still scanty. Although numerous individual measurements have been conducted, office equipment comes in a broad diversity of types and is subject to continual change as reflected in rapid product cycles. The exposure levels are very low, and mixed exposure will be the typical form of occurence.

It is a known fact, however, that health complaints are influenced to a significant degree by poor room climate (temperature and air humidity). These factors are usually easier to control than chemical or biological ones, and can therefore be remedied more easily as well. Thus, many U.S. studies from the 1980s and 1990s have shown that SBS often occurred due to improper functioning of air conditioning systems and could be reduced markedly through appropriate maintenance steps.

Approaching the issue from the health complaints side, the key illnesses incurred in offices can be reduced to four groups: allergies, infections, syndromes, and cancer. Of these, allergies are the most frequent while cancer has the lowest incidence. As noted earlier, mixed forms of health complaints are often referred to as syndromes, reflecting the complex and often unspecific pattern of the disorders experienced. A classification of illnesses by the above four disorder types is presented in **Table 3** (see page 5).

Most exposures in indoor office air lie in the low-dose range and are therefore difficult to measure and assess. In the majority of cases, the complaints pattern will be the result of a mix of different factors whose interaction tends to remain unclear.

Individual risk factors such as age, sex and susceptibility to specific illnesses may also have a certain impact on health complaints. In perceiving complaints, personal attitudes will often play a significant role [9]. Accordingly, psychosocial influences should be duly taken into account when determining and evaluating potential risk factors.

Table 2:
Potential exposures and sources currently under discussion.

Exposure	Sources
Ammonia	Cleaning solutions
Carbon dioxide	Human's exhaled air, combustion
Carbon monoxide	Tobacco smoke, combustion, automobile exhaust fumes coming in through open windows
Formaldehyde	Tobacco smoke, foam insulants, chipboard, adhesives, wood preservatives
Nitrogen oxides	Tobacco smoke, combustion, automobile exhaust fumes, gas heaters
Ozone	Photocopiers
Polycyclic aromatic hydrocarbons (PAH)	Tobacco smoke, paints
Polychlorinated dibenzodioxins/ dibenzofurans (PCDD/F)	Wood preservatives
Paints vapours	Paint on windows, doors, radiators
Polychlorinated biphenyls (PCB), dioxin, dibenzofuran	Electrical transformers, paint
Volatile organic compounds (VOC)	Photocopiers, carpets, plastics
Pesticides	Room plants
Solvents	Paints, adhesives, cleaning products, carpet, wallpaper
Tobacco smoke (active and passive), mainly: carbon monoxide, nitrogen oxides, acrolein, formaldehyde, PAH and various nitrosamines	Cigarettes, cigars
Odours	Various compounds
Automobile exhaust	High traffic density close to building
Asbestos	Insulation, ceiling
Dusts	House dust, toner dust, man-made fibres
Ionizing radiation due to radon and radon daughters	Emissions from the soil; leaks in basement floors permitting radon to enter
Microorganisms in the air (mould fungi, bacteria, viruses)	Ventilation system, air conditioning, old carpets, books, etc.
Microorganisms in moist medium (e.g., legionellae)	Humidifier, water supply
Animal excrements	Excrements of house dust mites

Table 3:
Overview of illnesses related to indoor air quality problems.

Illness group	Illness	Brief description
Allergies	Sinusitis	Inflammation of mucosae in the sinus cavities
	Rhinitis	Inflammation of mucous membranes of the nose
	Pharyngitis	Inflammation of the throat
	Conjunctivitis	Inflammation of the conjunctiva of the eye
	Extriusic allergic alveolitis	Hypersensitivity reactions of specific pulmonary epithelium cells to inhalation of organic dusts, specifically fungus spores and animal proteins. Symptoms: shortness of breath, coughing, fever, joint pain
	Allergic bronchopulmonary aspergillosis	Disorder of the lungs and bronchiae due to a dual allergic response, caused by the mould fungus *Aspergillus*
	Asthma	Bronchial disorder associated with airway obstruction
Infections	Legionnaire's disease	Influenza-type symptoms, confusion, sometimes grave course involving renal and pulmonary failure
	Viral infections	
	Q fever	Illness with severe influenza-type symptoms
Cancer	Diverse forms of cancer (rare)	
Syndromes (combinations of associated symptoms)	Sick-building syndrome (SBS), building-related health complaints (BRC), indoor air quality complaints, building-related symptoms (BRS), building-related illness syndrome (BRIS), idiopathic environmental intolerance (IEI), multiple chemical sensitivity (MCS)	Terms denoting health complaints attributed to polluted indoor air, chiefly involving unspecific symptoms of the respiratory tract, eyes, skin and central nervous system.

4 Outlook

Evaluating an office workplace in terms of relevant occupational safety and health criteria may be difficult given the diversity of potential risk factors involved, but a knowledge of these factors makes them much easier to detect and will also greatly facilitate workplace assessment. Once such factors have been identified, appropriate protective steps can be initiated. Risk avoidance is the first and foremost objective on which any prevention activity must be focused. Such activities may tackle the issue from a technical, medical, psychological or organizational angle. In most cases, measures addressing frequently reported issues will yield rapid success. Especially when it comes to air ventilation systems, sound planning, maintenance and monitoring should be a matter of course. Another important source of toxic impact in office air is passive smoking. In Germany, the amendment of the Workplaces Ordinance in October 2002 was a major breakthrough from an occupational safety and health view-

point. For a holistic safety and health protection approach to be effective, all hazard sources must be consistently avoided.

Apart from such avoidance of risk factors, previous experience should be taken as a guide wherever offices are newly built or furnished. Numerous aids are available today to facilitate the optimization of office workplace design, from procedural instructions, recommendations, consulting support, etc. [15 to 18]. Thanks to these tools, creating an optimum office environment is no longer a problem today. In most cases, information will also be available on how to improve the indoor air quality in offices so that illnesses will no longer occur.

Nevertheless, when assessing indoor air, many questions remain unsolved. Despite the joint efforts undertaken by many experts in this field and responsible labour safety and health professionals, the complex exposure situation and potential correlations call for more detailed investigations. An additionnal focus of research ought to be placed on identifying factors which hinder the implementation of appropriate protective measures aimed at improving indoor office air quality. It has often been found that preventive steps were inadequately put into practice although protective measures were known.

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