

# *Session 1A Overview of European projects on indoor air quality and health*

## **Development of WHO Guidelines for Indoor Air Quality (IAQ)**

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### **ABSTRACT**

The working group of the Global Update of WHO Guidelines for Air Quality recommended development of guidelines specific to indoor air, accounting for the global burden of disease associated especially with unvented indoor combustion of solid fuels and other factors that are not covered sufficiently by the general air quality guidelines. First phase to follow up consisted of a planning meeting convened in Bonn, Germany, in October 2006 that outlined a structure for the IAQ guidelines and identified exposure factors to be included into the IAQ guidelines. The factors include - next to traditional pollutant specific approaches - also biological agents and indoor combustion. In the second phase, the guideline development process is started from the subgroup of biological agents, followed up by addressing policy implications of actions to reduce health risks due to indoor air pollution with biological agents in the third phase. Further work on air pollutants and indoor combustion is to be developed in the near future.

### **PHASE 1: FOCUSING ON INDOOR AIR**

The WHO Air Quality Guidelines (AQG) are designed to offer guidance in reducing adverse health impacts of air pollution based on expert evaluation of current scientific evidence. Especially, various problems in indoor air quality are recognized as important risk factors for human health in both developing as well as developed countries. The basic right for, and importance of, healthy indoor air has been emphasized also by the World Health Organization (WHO, 2000a).

Importance of indoor air is magnified by the substantial fraction of time populations spend within buildings. Indoor combustion is a source of pollution causing severe burden to health, especially for children and women in developing countries. In residences, day-care centres, elderly people homes and other special environments, indoor air pollution affects population groups that are especially susceptible due to

their health status or age. There is a substantial body of research on health effects of indoor exposures, listing many potentially hazardous compounds released indoors due to combustion, emissions from building materials, household equipment and consumer products. Microbial pollution comes from hundreds of species of bacteria, fungi, and moulds growing indoors. Indoor air quality management is made difficult not only by the large number and variation of indoor spaces but also the complex relations of indoor air quality and the building design, materials, operation and maintenance, ventilation and behaviour of the building users.

The recent update of the WHO AQG (WHO 2005, 2006a) for particulate matter, ozone, nitrogen dioxide, and sulphur dioxide specified that the AQG applied in all non-occupational environments, including indoors in households, schools, vehicles, etc. Although such traditional AQG in the form of concentrations for specific pollutants based on scientific review and assessment of health effects have been widely used in outdoor air quality management, they have had relatively little impact on management of indoor air quality in most countries.

Recognizing that management of air quality indoors requires different approaches to those applicable to outdoor exposures, the recent AQG update recommended that WHO explore development of AQG specifically designed to facilitate management of indoor air quality around the world.

## SYSTEMATIC REVIEW APPROACH

The development of the WHO Indoor Air Quality Guidelines (IAQG) will be based on systematic review of the scientific evidence on health relevance of various pollutants in the indoor air and factors affecting indoor air quality. The principles of such a systematic review for health impact assessment are presented in the WHO guideline document (WHO, 2000b).

WHO guidelines are recommendations based on scientific evidence on health effects of certain exposures. Formulation of guidelines as exposure levels gives an objective measure of health risk that can be used as a reference point for design and maintenance of safe indoor environments. The use of the guidelines to create national and international legislation and standards needs to consider feasibility of various approaches besides direct control of indoor concentrations, including taxation of fuels and products, product and equipment use, maintenance, product composition, labelling, building construction, ventilation and education of professionals and the public to account for the importance of the indoor air quality for public health. However, as some exposure factors cannot be fully characterized using a concentration-based approach in the guideline formulation that has been used in the previous WHO guidelines (WHO, 1987, 2000c, 2005, 2006a), the indoor air guideline work needs to consider also qualitative indicators of health hazards and address them using guidance based on indicators of the hazards. Specifically, the guidelines should

- address various level of economic development,
- cover all relevant population groups and
- enable feasible approaches to reduce health risks from indoor air pollutants.

## WORKING GROUP MEETING FOR START-UP OF THE WORK

Existing national and international experiences in indoor air quality regulation and conclusions of completed international projects provided the required background information for the WHO Working Group that convened in October 23-24, 2006, in Bonn with 38 experts, as well as representatives and observers from national and international institutions (WHO, 2006b).

In a series of plenary discussions and small drafting group sessions, the Working Group reviewed the general approach to the guidelines' formulation, discussed their scope and format, and agreed on the general contents of the background material. The final recommendations concerning the guideline development were made in plenary by consensus.

## EVIDENCE REVIEW AND PRIORITIZATION

Due to the diversity of exposure conditions in indoor settings, three different areas requiring complementary approaches were identified:

- A – Air pollutant specific guidelines
- B – Biological agents
- C – Combustion of solid fuels and kerosene

The working group divided into three parallel sessions to consider these areas separately, to assess the topics global importance for health, to summarize the existing scientific evidence, and give recommendations on the factors relevant for inclusion in the guideline development process. Conclusions of each subgroup are discussed shortly separately below.

### Group A: Air pollutant specific guidelines

The task of the sub group was to identify those specific pollutants and agents that would require specific attention due to the characteristics of indoor environments.

The group identified a number of relevant systematic reviews and risk assessments of pollutants present in indoor environments. These reviews should be used as inputs to the development of the indoor air quality guidelines. One of the issues to be considered is the use of information from epidemiological studies based on ambient pollutant levels as exposure indicator.

The group also concluded that the WHO guidelines for environmental tobacco smoke (ETS) published in WHO Air Quality Guidelines for Europe, 2nd Edition (WHO, 2000c) and stating that there is no evidence for safe exposure level are clear and still valid. Therefore it was recommended not to include ETS in the current work. Plenary discussion concluded that the guidelines for other pollutants should be developed based on the assumption that ETS - a well recognized health hazard - is eliminated from the indoor spaces.

### Group B: Biological agents

Exposures to biological agents in indoor environments were identified as a significant health hazard causing a wide range of health effects. There is vast evidence on hazards of several biological agents such as viruses, bacteria, damp, fungi, mites, pollens and allergens. However, the group concluded unanimously that in most cases it is not possible to identify individual species of the microbes or other specific biological agents responsible for the health effects. The exceptions are some common allergies, which can be attributed to specific agents or exposures, such as house dust mites or pets.

Biological agents in the indoor environment are attributable to dampness and inadequate ventilation. Excess moisture on any material leads to growth of microbes such as moulds, fungi and bacteria, which subsequently emit spores, cells, fragments and volatile organic compounds into the indoor air. Moreover, dampness initiates chemical and/or biological degradation of materials which also causes pollution of the indoor air. Dampness has been therefore suggested to be the strongest and most consistent indicator of risk for asthma and respiratory symptoms (e.g. cough and wheeze).

Inadequate ventilation is strongly associated with adverse health (sick building syndrome, inflammation, infections, asthma, sick leave, etc.) and reduces work performance in office buildings and learning capacities of students in schools. Proper ventilation is an important control for humidity, and prevention of condensation.

It was pointed out that ventilation systems may act as a source of health hazard e.g. in case of microbial growth and VOC emissions from accumulated sediments in the ventilation systems, but that overall ventilation should be seen as the solution for most indoor air quality problems, including those associated with biological agents.

### Group C: Combustion of solid fuels and kerosene

Particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>) as well as carbon monoxide (CO) are good indicators of a large group of pollutants emitted in combustion of solid fuels. The group recognized that the current air quality guidelines for PM provide targets which are also valid for indoor environments. However the current guidelines for carbon monoxide (WHO, 2000c) need to be updated to reflect new information on chronic effects and to assure sufficient protection against acute poisoning in solid-fuel using households.

There are big differences in exposure levels to pollutants from solid fuel use between developing and developed countries. The group recognized that measurements of indoor air quality are difficult to be performed especially in developing countries, and that substantial improvements in reducing exposures can be achieved merely using indicators like “use of solid fuels indoors without proper ventilation / chimney” for identification of the need for action and formulation of corresponding technological recommendations regarding fuels, stove types, venting etc.

However, when available, measurements of indoor air quality provide quantitative information on the exposures, and in case of interventions allow assessing the

efficiency of the selected actions. There is much room left for technological solutions in exposure reduction (particularly for cooking) as relatively few resources have yet been applied.

The group set the focus of the development of indoor air quality guidelines on exposures to emissions from household use of solid fuels and kerosene, not just for heating and cooking but including also e.g., lighting and small commercial activities in households.

The group deliberated on plausible technical solutions to effectively control the sources and exposure pathways and listed the processes/solutions to be considered in the guidelines for indoor air quality:

## PHASE 1: CONCLUSIONS

The recommendations for pollutants, agents, and factors to be included in the WHO IAQG were discussed in detail in the sub groups for agent specific guidelines, biological agents, and combustion of solid fuels. The recommendations of the small groups were presented in the plenary, discussed and finally agreed on. The pollutants and factors to be included in the guidelines are presented in the table 1.

In addition, the Working Group agreed on the role of indoor air quality as a significant determinant of population health. The development of WHO guidelines specific for indoor air quality is recommended for several reasons:

- Wide range of sources of air pollution specific to indoor spaces;
- Specificity of some exposures in indoor spaces in terms of pollution composition and exposure levels;
- Large fraction of time spent indoors affects population exposures;
- Separation of indoor and outdoor spaces which modify the exposures to a number of pollutants.

Besides the health-based recommendations for concentration levels not to be exceeded, the guidelines may formulate recommendations concerning indoor air quality problems using qualitative indicators, such as existence of dampness in the building structures leading to microbial growth or use of solid fuels in indoor spaces.

Table 1. Summary of factors to be included in the Guidelines on IAQ (WHO, 2006b)

<b>Group A</b>	<b>Group B</b>	<b>Group C</b>	
<b>Pollutants</b>	<b>Biological agents</b>	<b>Indoor combustion</b>	
Formaldehyde	<b>Dampness and mould</b>	<b>Stove venting</b>	
Benzene		- flues	
Naphthalene		- hoods	
Nitrogen dioxide (NO <sub>2</sub> )	<b>Ventilation</b>	<b>Ventilation</b>	
Carbon monoxide (CO)		- natural	
Radon (Rn)	- forced / mechanical	- forced	
Particulate matter <sup>1</sup>		<b>Combustion quality</b>	
Halogenated compounds	<b>Allergens</b>	<b>Fuels</b>	
PAH <sup>2</sup> , especially BaP <sup>3</sup>		- from house dust mites	- solid
		- from pets	- processed solid
		- liquid	
		- gas	
		- electricity	

<sup>1</sup> PM<sub>2.5</sub> and PM<sub>10</sub>, <sup>2</sup> Polycyclic aromatic hydrocarbons, <sup>3</sup> Benzo[a] pyrene

## DEFINITION OF INDOOR SPACES TO BE INCLUDED

The working group discussed how to define the indoor spaces that should be covered by the guidelines. It was concluded that the WHO guidelines for indoor air quality should cover indoor settings in which the general population or especially susceptible population groups like children, elderly, asthmatics etc. are potentially exposed to indoor air pollution. These include homes, schools, day care centres, public places as libraries or institutionalized settings like nursing homes. However, conditions that are specific to exposures in industrial settings, agriculture, mining and in other occupational settings where the exposure is related to the occupational activity of the occupants cannot be adequately addressed by the general guidelines for indoor air quality. Such settings are typically covered by work safety legislation or guidance.

As a first step in the development of IAQG, WHO decided to initiate a project to establish first recommendation on guidelines for biological agents, focusing on damp, mould and ventilation.

## PHASE 2: TOWARDS WHO GUIDELINES ON INDOOR AIR QUALITY FOR MOULD, DAMPNESS, AND VENTILATION

As the first step in implementation of the recommendations of the WHO Working Group on IAQ guidelines, WHO established the steering group, which will supervise the WHO process and will advise WHO on all relevant scientific issues related to the Guidelines development and will assure consistency of the IAQ Guidelines development with the general approaches adopted for WHO AQG. The list of Steering Group members is available on the website

[http://www.euro.who.int/air/activities/20070510\\_1](http://www.euro.who.int/air/activities/20070510_1).

WHO has initiated the development of Guidelines on dampness, mould and ventilation in spring 2007. It will be based on the review of health issues affected by dampness and mould in indoor spaces as well as the relation of health to ventilation system (both as a source of health hazard and as a part of solution to IAQ problems). These Guidelines should cover indoor settings in which the general population or especially susceptible population groups like children, elderly, asthmatics etc. are potentially exposed to indoor air pollution.

A group of experts with experience in epidemiology, toxicology and clinical aspects of health effects of exposure to biological agents in indoor air, experts in conditions affecting presence of biological contaminants in indoor air was invited to review the scientific literature and prepare background material according to the following structure:

1. General description
2. Effects of dampness on sources of indoor air pollutants and resulting exposure
3. Ventilation in relation to mould and dampness
4. Health effects associated with mould and dampness
5. Evaluation of human health risks

The WHO Working Group meeting will be convened in October 2007. It will formulate the Guidelines and will agree on detailed recommendations concerning finalization of background material to be contributed as the chapters of the WHO Guidelines for IAQ. The meeting report will be published on WHO web page. It will contain the summary of the workshop discussion and its conclusions, including the recommended text of the Guidelines sections for both chapters.

### **PHASE 3: ADDRESSING POLICY DEVELOPMENT FOR REDUCTION OF HEALTH RISKS DUE TO INDOOR AIR POLLUTION ASSOCIATED WITH BIOLOGICAL AGENTS**

WHO recommendations for IAQG for damp, mould and ventilation are planned to be available by the end of 2007. However, the implementation of specific actions to achieve such Guidelines is still a difficult area for public health due to the great variety of indoor spaces, fragmentation of responsibilities and, in case of homes, limited mandate of public authorities for interventions.

Therefore a separate WHO project (a part of the project co-sponsored by EC DG Sanco, grant agreement 2005156) on policy implications of IAQG for damp, mould and ventilation will accumulate evidence on the actions implemented in various countries to address health hazards associated with dampness and mould and with inadequate ventilation, and will assess their effectiveness and suitability for reaching conditions as defined by the IAQ guidelines. This review will consider practical constraints of various risk management approaches, as well as their feasibility and costs, and will formulate recommendations for public policy aiming at the reduction of health impacts of biological contaminants of indoor air.

The major objectives of this project are to increase national and international capacities to

1. develop and apply national policies addressing health risks due to biological contaminants of indoor air, and in particular those risks generated by dampness and mould as well as inadequate ventilation.
2. advocate for action on the indoor air quality across sectorial policies and facilitation of implementation of WHO Guidelines on IAQ.
3. mitigate exposure to biological contaminants of indoor air within the housing stock and / or schools as a means to protect the more vulnerable parts of the population (sick, elderly, children) that spend most time within these indoor spaces.

For providing adequate mechanisms, tools and technical solutions, the project will aim to develop:

- a variety of good practice examples from European countries, showing innovative, adequate, realistic and successful approaches towards improving IAQ
- policy briefs summarizing the most effective actions and approaches facilitating practical application of the WHO Guidelines on IAQ for dampness and mould, and for ventilation.

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