



Technical and policy recommendations to reduce health risks due to dampness and mould

Project Report



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ABSTRACT

The presence of dampness or biological agents such as mould in indoor air or building structures is largely attributable to occupant behaviour, building characteristics and, in particular, to condensation, inadequate ventilation and structural failures. Although the presence of dampness and mould has been confirmed as a health threat, the health sector has responded to this challenge with little action. In part, this lack of action is due to the lack of guidance and recommendations on actions against dampness and mould.

To provide recommendations on policy actions and frameworks that support interventions against dampness and mould, WHO reviewed technical interventions as well as national policies and regulations to discuss the best mechanisms for the protection of public health and the reduction or mitigation of exposure to dampness and mould problems in indoor settings.

This WHO report consists of the two expert meeting reports that were held in the context of this project. The first meeting report summarizes the review of technical actions and interventions against dampness and mould which were provided as case studies from a variety of countries. It provides a range of recommendations on good technical practices to prevent, reduce or remove dampness and mould.

The second meeting report provides policy-related recommendations and identifies potential ways for international, national and local authorities to prevent, reduce or mitigate exposure to dampness and mould. It will enable policy-makers to identify appropriate measures to support and advocate in the field of public health protection and will provide them with relevant examples and guidance for policy and regulatory measures.

This report complements the WHO indoor air quality guidelines: dampness and mould with recommendations on actions for achieving conditions recommended by the WHO guidelines.

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Keywords

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Edited by: Thomas F. Petruso and Jerome Rosen

CONTENT

Executive summary	1
Technical recommendations on actions and interventions against dampness and mould.....	1
Legal and regulatory context.....	2
Recommendations for action and actors	3
Meeting report: Technical interventions and actions against dampness and mould. 28-29 February, 2008.....	4
Context and objectives of the meeting.....	4
Case study collection and pre-selection.....	5
Approaches against dampness and mould.....	6
Working group sessions: conclusions and recommendations	7
Working Group 1: Good practice elements and recommendations from scientific perspective.....	7
Working Group 2: Good practice elements and recommendations from problem perspective	9
Working Group 3: Good practice elements and recommendations from process perspective	11
Meeting conclusions.....	15
Technical actions and interventions against dampness and mould	15
Policy dimensions of the case study review.....	16
Project perspectives.....	17
Annex 1: Case study summary	18
Annex 2: List of participants.....	33
Meeting report: Policy recommendations on interventions and actions against dampness and mould. 9-10 February, 2009.	36
Context and objectives of the meeting.....	36
Review of existing recommendations on dampness and mould	37
Application and health benefits of policies on dampness and mould.....	40
Working group sessions: conclusions and recommendations	42
Working Group 1: (inter)national regulatory frameworks.....	42
Working Group 2: local implementation mechanisms.....	46
Working Group 3: public perspective – guidance, support and information	49

Meeting conclusions.....	54
Legal and regulatory context.....	54
Local authorities and their mandate	54
Provision of information and support mechanisms.....	55
Professional sectors.....	56
Preventive approaches.....	56
A call for holistic approaches to healthy built environments.....	56
References.....	58
Annex 1. Summary of recent recommendations on dampness and mould policies.....	63
Annex 2. National summaries on dampness and mould policies and/or regulations	98
Annex 3. List of participants	120
Annex 4. Abbreviations	123

Executive summary

Exposure to biological agents in indoor environments is a significant health hazard, causing a wide range of effects. Mould growth and the subsequent presence of biological agents in the indoor air is attributable to housing characteristics, and particularly to dampness, condensation, inadequate ventilation and structural failures.

The WHO indoor air quality guidelines on dampness and mould (2009a) have recommended the prevention and remediation of dampness and mould in indoor spaces. Practical implementation and evaluation of such actions is difficult due to the great variety of indoor spaces, the fragmentation of responsibilities between different actors and, in the case of private residences, a limited mandate for interventions by public authorities.

To develop technical and policy recommendations for reducing health risks due to dampness and mould, WHO has carried out a project on “Addressing policy implications of actions to reduce health risks due to indoor air pollution with biological agents” which reviewed the effectiveness of actions and interventions in indoor settings and developed policy guidance. In the context of this project, WHO collected case studies on actions and interventions in indoor settings which were reviewed and discussed during an expert meeting in February 2008. Based on the technical assessment of these interventions and a review of existing policy frameworks, a second expert meeting (February 2009) developed a range of policy recommendations.

The evidence and policy frameworks reviewed during this project can be summarized by three major statements:

- 1) There is adequate evidence linking the exposure to dampness and mould in the building with negative health outcomes.
- 2) There is restricted but reliable evidence showing that dampness and mould remediation measures are successful if adequately implemented.
- 3) National policies and regulatory frameworks regarding dampness and mould tend to be vague and in most countries, no public mandate is given in the case of private homes.

Addressing these issues and providing Member States with guidance on appropriate measures against dampness and mould in built environments, the project generated the following technical and policy recommendations:

Technical recommendations on actions and interventions against dampness and mould

The imperative for health and housing actors must lie in the prevention of dampness problems in housing to avoid subsequent health effects. This calls for adequate maintenance of the housing stock as well as the public buildings (and especially day care centers, schools, elderly homes etc.). When contamination with moulds has already occurred, the physical removal of mould and mould-affected materials is considered the main strategy for remediation and various case studies have proven its effectiveness.

Before remediation work, an adequate assessment of the magnitude of the contamination problem, as well as a thorough identification of the root causes of damp, moisture or mould occurrence is necessary. Understanding of the causal mechanism is considered the key measure for successful and sustainable remediation and prevention. Consequently, the exact measures strongly depend on the given problem and the characteristics of the affected building, as well as the use or function of the building.

The balance between moisture, air exchange rate and surface temperatures (both indoor surfaces as well as surfaces within the building structure) has been identified as the main objective for both remediation and preventative measures. Therefore, applicable and affordable solutions are needed to either reach such balanced conditions in damaged buildings, or prevent unbalanced conditions in general terms.

In the case of dampness and mould remediation, actions need to be taken to ensure that conditions supporting mould growth do not reappear. Moisture control measures therefore are an integral part of any mould mitigation project.

To eliminate subsequent problems from dampness and mould, preventive measures must be intensified already from the design and construction of new buildings. This is particularly relevant in combination with measures to reduce energy consumption. The working group therefore agreed that the key approach – in terms of both policy and technical aspects – should be to avoid and prevent, and if necessary reduce and minimize, the problems of excessive dampness, condensation and mould growth.

Legal and regulatory context

The legal settings provided by most countries to deal with dampness and mould problems tend to be vague, requiring expert knowledge to identify potential problems and to select and implement the correct actions and interventions. More specific regulations, providing performance-based standards to be kept and maintained by the responsible housing actors, need to be developed to better control the housing conditions and quickly identify inadequate conditions that need to be tackled.

Clear regulations and legislative tools, based as much as possible on defined health-based end-points, will help to describe the responsibility of the occupants, but will also help residents to request that remedial action is undertaken by the building owners or housing agencies.

Regarding the framework provided by the Directive 2002/91/EC of the European Parliament and of the Council on 16 December 2002 on the energy performance of buildings (European Parliament, Council of the European Union, 2003), there is considerable concern about the dominance of the energy saving arguments in relation to the requirements for sufficient air exchange and the quality of indoor environments. National applications of the Directive, and especially the energy certificates, should give more consideration to the general requirements for an adequate indoor climate and the balance between energy efficiency and ventilation needs.

Irrespective of the level of regulation and enforcement, it is recommended that dampness and mould issues be dealt with in the context of healthy buildings and be considered as one potential problem of many. Policies intended to affect dampness and mould – or biological contamination

in general – should therefore be embedded in more general strategies and campaigns on healthy housing, healthy schools, or healthy buildings.

Recommendations for action and actors

Local authorities should – if not yet available – be equipped with a clear mandate (including budget and/or resources) to work on the problem of damp and mouldy buildings, as they are the level of public authority closest to the people. Local authorities should also find suitable ways to provide a minimum set of services for households living in private housing stock. In addition, local authorities should include the prevention of dampness and mould in the work mandate of their departments of health, environment, social services and housing.

With regard to the **provision of information** on dampness and mould, there is a need to identify the population groups most in need of information and support and to provide them with such help in pragmatic terms.

Specific information needs to be developed and disseminated to **vulnerable population groups** – such as people with asthma, allergies or respiratory disorders; immunocompromised people; and children and the elderly.

As **building users** are not specialists trained in building inspection, it is most relevant for them to be aware and informed of the key indicators and so-called tell-tale signs that indicate problems with moisture or mould (or building problems in general).

The development of **housing manuals** that summarize the operative tasks and challenges of the building, its construction style and its equipment is generally supported. However, building manuals can not replace the need for adequate building construction and regular building maintenance by professionals, and especially the identification of potentially invisible or hidden problems (for example, within the building structure).

For the **medical professions**, a lack of awareness of environmental triggers of disease was noted as a major challenge to be tackled. To avoid that - after diagnosis of allergic or respiratory diseases possibly related to the indoor environment - patients are sent back to their home which may be the source of the problem, medical experts should be made aware of key indicators and typical health outcomes associated with indoor environments. Appropriate mechanisms for including the home (or school or office) environment in medical diagnosis and therapy choices should be developed and supported.

The **housing and construction sector** needs to consider modification of training and education curricula, to increasingly address the relevance of building quality and its links to health. To this end, the larger housing agencies and umbrella organizations should develop – in close collaboration with the health community – guidance for their members.

Meeting report: Technical interventions and actions against dampness and mould. 28-29 February, 2008.

Context and objectives of the meeting

Exposure to biological agents in indoor environments is a significant health hazard, causing a wide range of effects. The presence of biological agents such as mould in the indoor air is attributable to housing characteristics, particularly dampness, condensation, inadequate ventilation and structural failures. Signs of dampness and/or mould are considered strong indicators of risk for asthma and respiratory symptoms (e.g. coughing and wheezing). Ventilation and temperature, on the other hand, are important control mechanisms for humidity and the prevention of condensation. In addition, ventilation plays an important role in reducing concentrations of microbial and chemical pollutants in the air.

A WHO working group on indoor air quality guidelines has made recommendations on dampness and mould in indoor spaces, but the implementation and evaluation of specific actions is difficult due to the great variety of indoor spaces, fragmentation of responsibilities and, in the case of private residences, a limited mandate for interventions by public authorities.

To review practical interventions and their effectiveness, WHO collected case studies on actions and interventions in indoor settings. The meeting participants discussed a selected set of the studies, and identified elements of good practice based on the actions and technical measures described in them.

This meeting was part of a larger work package on “Addressing policy implications of actions to reduce health risks due to indoor air pollution with biological agents” carried out by the WHO European Centre for Environment and Health (Bonn Office) and co-funded by the European Commission (DG Sanco, grant agreement 2005156). With the overall objective of formulating policy briefs on effective approaches against dampness and mould, the review meeting aimed at assessing and evaluating actions carried out in indoor settings in order to:

- learn about practical actions of involved parties
- categorize actions and approaches
- scientifically assess methodologies
- identify elements of good practice.

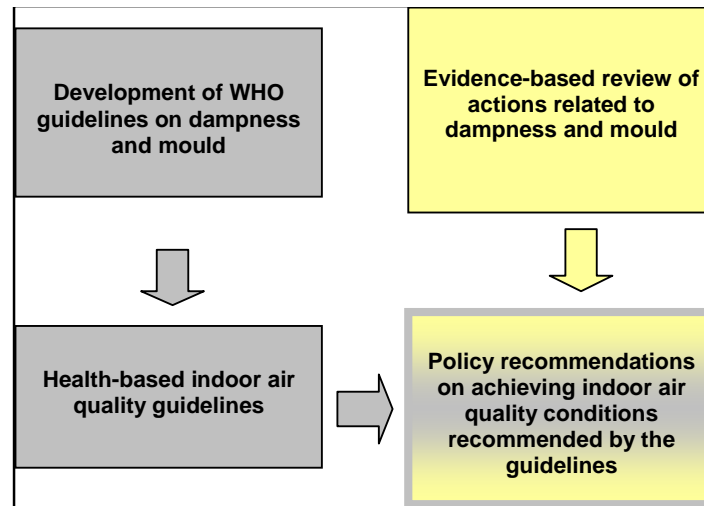
The results of this meeting are thus background material for a future meeting to discuss policy options and recommendations on actions to prevent, reduce or mitigate dampness and mould exposure in indoor and built environments.

The policy advice on dampness and mould actions provided by this work package will also complement the WHO guidelines on dampness and mould¹ published in 2009. As the WHO guidelines on dampness and mould are restricted to a health risk assessment based on scientific evidence, risk management options are not addressed. Therefore, the work package’s risk management aspect – along with the European Commission’s policy advice – will also provide

¹ WHO (2009a): WHO guidelines for indoor air quality: dampness and mould. Available at: http://www.euro.who.int/air/activities/20070814_1

mechanisms and practical recommendations for implementing WHO guidelines on dampness and mould. Together, both projects are expected to provide strong scientific and policy-related foundations for national and international measures (Figure 1).

Figure 1: Science and practice – towards policy-making on dampness and mould



The feasibility of actions and interventions was emphasized, and their potential utility in preventing the problems related to dampness and mould in the first place.

Case study collection and pre-selection

As a first step towards the development of policy advice on actions against dampness and mould, a case study collection was carried out to compile an evidence base of risk management actions in different countries. The collection of case studies aimed at projects targeted at the prevention, reduction or mitigation of dampness and mould problems, such as:

- reduction of indoor relative humidity
- reduction of dampness/condensation
- removal/prevention of mould
- improvement of ventilation.

Due to special regulations in work places and health care institutions, they were excluded. The case study review therefore included residential buildings, schools and child and elderly centres with a focus on non-care elements.

The collection of case studies was carried out through a variety of mechanisms and information channels, including information from the WHO network and collaborating national and international expert networks, calls for case studies at conferences and public expert meetings, appeals to national building and engineering research institutions and searching the proceedings and abstract books of relevant international conferences. In total, several hundred sources were addressed and a more detailed follow-up was carried out with 60 experts who received the case study template for submission of case studies. Out of the 60, 21 contributed a total of 30 case studies.

The 30 case studies received were subject to a first review and pre-selection carried out by WHO in collaboration with the advisory group of the project² and the WHO Collaborating Centre for Housing and Health.³ The pre-selection focused on the scientific validity and completeness of case studies in relation to the three main parameters (measurement of exposure, measurement of health effects, description of actions undertaken) and selected 17 case studies for discussion at the meeting.⁴

A summary of the selected case studies, the review process and the overall rating of all case studies is available in Annex 1, which also describes gaps and weaknesses such as:

- few case studies from schools and institutional settings
- lack of studies from warm climates
- difficulty relating health effects to specific measures
- lack of reliable exposure and health measurements in many case studies.

All case study templates discussed at the meeting can be accessed at http://www.euro.who.int/Housing/support/20080403_1.

Approaches against dampness and mould

Before the discussion of individual case studies, the variety of approaches and action mechanisms to prevent, reduce or mitigate dampness and mould problems were highlighted and shortly introduced by focus presentations. The following mechanisms were all reflected by the case studies, and provided reasonable evidence of relevance and utility.

Impact of remediation activities

Remediation activities include removal of dampness and mould problems and repair of dysfunctional building structures, with removal of damaged or contaminated material. The key to remediation success is identifying the source of the problem, rather than merely addressing the consequences. Essentially, this means preventing the accumulation of moisture.

Impact of thermal insulation

There has been a trend in recent years toward increased insulation and energy efficiency in buildings, which may diminish indoor air quality due to reduced air exchange rates and increased humidity and condensation due to higher temperatures. Several case studies based on thermal insulation projects and interventions have shown that insulation can inhibit the reduction of dampness and mould if not accompanied by adequate ventilation.

Impact of ventilation

Ventilation is the main mechanism of removing pollutants, dampness and humidity from buildings. Although the effectiveness of ventilation depends a lot on the outside conditions (ventilation is much more effective in cold and dry climates), it is a controlling factor for indoor conditions in any climate. Case studies show that the ventilation capacities of buildings, as well as ventilation behaviour of their occupants, are frequently associated with problems of dampness and mould. Mechanical ventilation, which is the only means for controlling and optimizing

² Dr De Cuyper, Belgium; Dr Kelly, UK; Dr Kurnitski, Finland; Dr Szewzyk, Germany

³ Dr Kompauer / Dr Link, Germany

⁴ Four additional case studies were suggested for discussion by a specific working group on processes.

ventilation rates, is becoming more important as natural air change becomes less prevalent in modern buildings.

Impact of education

Many companies are actively involved in the remediation or removal of indoor mould and mould-damaged material. Some case studies have targeted the education or certification of professional staff to assess compliance with national guidelines and recommendations on mould removal, and training has been offered on regional or municipal levels to maximize the health impacts of remediation activities.

Information campaigns / capacity building

In addition to professional services, which often are called to deal with large problems, untrained building occupants and others also undertake mould abatement and removal activities. To support such do-it-yourself activities, information campaigns disseminate practical guidance on work procedures, via a variety of materials and media. Informational activities targeting the public also increase general awareness and knowledge, thereby reducing dependence on professional services.

Municipal action

Public authorities are directly responsible for protecting the health of users and occupants of public buildings and institutions. Therefore, regular inspections and hygiene checks are mandatory. In private homes and dwellings, there is no such obligation. However, several municipalities or authorities have supported the development of public or semi-public services aimed at protecting private homes and rental units from dampness and mould.

Due to the restricted number of relevant case studies, a comparative assessment of the described approaches is not possible. Also, many case studies have considered various approaches in parallel, combining technical, informational and procedural mechanisms, generally concluding that these approaches are valid and potentially effective when adapted to specific building and climate conditions.

Working group sessions: conclusions and recommendations

Three working groups were charged with consolidating a list of good practice elements from the selected case studies and making recommendations on their basis. The format for each working group (with a chairperson and rapporteur) was a first afternoon group discussion followed by a presentation of the group's findings to the plenary group on the morning of the second meeting day. Each working group then reconvened for a final discussion and drafting of a condensed set of conclusions and recommendations, taking into consideration the comments of the plenary group. The final recommendations were then presented to and shortly discussed at a final plenary session.

Working Group 1: Good practice elements and recommendations from scientific perspective

Chair: Kurnitski; Members: Davies, Emenius, Kolb, Kompauer, Molhave, Slotova

Working Group 1 assessed the case studies from a scientific perspective, trying to identify which showed the most reliable intervention result for purposes of the meeting discussion. The strengths and weaknesses of each case study were discussed, leading to an overall assessment of

the results' reliability. Of the 17 case studies, the group identified 9 as having sufficient information on the relevant parameters for assessment. The main reasons for non-selection were:

- lack of adequate health measurements
- retrospective measurements of health by questionnaire only
- inadequate measurement of dampness or mould exposure
- lack of information on remedial actions undertaken
- weakness of study design (lack of control group, comparison of different buildings, etc.)
- lack of integration of relevant confounding factors.

Although non-selected studies may still be scientifically valid and reliable, they were considered less appropriate or not sufficient for the meeting discussion requirements. The group noted that the unselected case studies may also contribute useful elements for dampness and mould mitigation or prevention. In addition, the group cautioned that there is a large body of scientific evidence that has to be considered in preparing final recommendations.

The case studies provided reliable scientific evidence supporting the recommendations below. As a key conclusion, the group highlighted that moisture control is essential because dampness and mould problems basically are consequences of inadequate moisture control. In mitigation, the removal of contaminated material is equally essential. Therefore, the group made separate recommendations for general prevention and for remediation of existing problems.

Working Group 1 identified the following lessons and recommendations concerning prevention:

- Preventive measures are essential in avoiding dampness and mould problems.
- Occurrence of mould is a result of inadequate moisture control resulting from one or (most often) more factors such as incorrect design, construction errors, inadequate building maintenance or use and natural disasters.
- Building design should consider climate, culture and location as well as the intended use of the building.
- Regulations, codes, standards and guidelines should require effective control of moisture in buildings, including sources of moisture and ventilation as well as the hygrothermal quality of the building envelope.
- New buildings should be designed to meet a broad range of functions and occupant behaviours.
- Measures that reduce humidity below (nationally) specified values should include consideration of the moisture balance and ventilation consequences.
- Ventilation systems and devices can be effective moisture control measures, as they have the potential to reduce indoor humidity.

The group derived the following recommendations for remediating existing problems:

- Proper remediation can solve indoor mould and dampness problems.
- Proper remediation includes both moisture control and mould abatement.
- Remediation work should be done promptly and rapidly.
- To be successful, remediation must remove or mechanically clean all mould and contaminated materials as appropriate, and enable better moisture control.
- Targeted or partial renovation can also produce significant results.

- Remediation measures should be selected according to the nature of the problem; several parallel interventions may be needed.
- Building designs may have to be adapted to obtain better moisture control.
- New insulation, air tightening or changes in building function should be compensated by appropriate design or technical measures to keep humidity below specified (national) values.
- Remediation should take into account building use and occupant behaviour and health status.
- Installation of ventilation systems and devices can be effective moisture control measures as they have the potential to lower the indoor humidity.
- Occupants should be made aware of their potential role in causing dampness and mould problems, so that they do not counteract the remediation results.

Many case studies show that remediation and removal of contaminated material lead to a significant reduction in exposure, but do not always include assessments to show that this is reflected in health improvement. Although it is desirable that health impact measurements be performed, the main objective interventions must be the removal of the sources of exposure, as scientific evidence shows that the reduction or termination of exposure is a key requirement for associated health improvement.

Working Group 2: Good practice elements and recommendations from problem perspective

Chair: Haverinen-Shaughnessy; Members: Becker, Bogs, Buzyte, Hofbauer, van Loenhout, Walusiak, Wolz

Working group 2 approached discussion of the case studies from a pragmatic and problem-oriented perspective, looking in more detail at the interventions in relation to the described problem and indoor setting. Contrary to group 1, which based its recommendations on more general scientific criteria, group 2 was more interested in technical solutions to the problem. Although the large majority of case studies referred to private dwellings, they were still considered relevant for all indoor spaces as the setting does not play a major role in remediation measures.

The working group first identified the types of problems that were described by the selected case studies, and identified – aside from problem of mould growth – a number of problems that needed to be addressed by building interventions.

Technical problem description	Case studies	%
Mould growth	17	100
Higher indoor relative humidity	10	59
Rain water seepage	7	41
Lack of ventilation	7	41
Inadequate heating	6	35
Damaged construction materials	5	29
Increasing dampness	3	18
Internal moisture sources	2	12
Unventilated crawl spaces	2	12
Plumbing leakage	1	6
Spread of contaminants by HVAC system	1	6
Major flooding effects	1	6

It seems reasonable to expect that these types of problems are typical and provide a rough overview of the technical challenges in dampness and mould remediation. The main problems associated with mould exposure in the selected case studies were higher indoor humidity levels, leaks and lack of adequate ventilation and heating.

The group noted that there are a variety of technical problems that may additionally be associated with mould problems, but are not reflected in the case studies, including moisture inside building structures, interstitial condensation, construction moisture, aging materials and the exposure to high outdoor humidity.

Key elements of successful actions were listed by the group during the review of the case studies, and are summarized below. However, due to the variety of project objectives and remedial action taken, most case studies only covered a few of these practices. No case study implemented more than five of the suggested elements, which are:

- examination of buildings by experts with proper tools
- resolution of moisture problem causes
- removal of mould as well as damaged material (mechanical or chemical cleaning)
- drying remaining structures
- improvement of ventilation and thermal insulation
- use of proper materials that do not promote mould growth
- protection of workers
- prevention of cross-contamination by separating clean-up areas from non-infected areas initiating remediation work as soon as possible
- minimizing the remediation period to prevent occupant discomfort
- relocation of occupants to reduce exposure and health complaints
- follow-up of remediation and quality control.

In addition, the group stated that from a pragmatic perspective, it may be necessary to set priorities, as not all remedial action can be performed at once. Based on the case studies, it seems that with the right priorities, partial remediation can be successful.

The working group observed that high-occupancy buildings are more prone to health problems from dampness and mould, and that geographical location may be a factor (e.g., northern exposures may be associated with more humidity problems). The relevance of thermal conditions and indoor surface temperatures for the prevention of condensation was highlighted as well as the necessity of adequate ventilation in relation to the climate. Finally, it was stated that ventilation systems should be quiet to make their use acceptable to building occupants.

The group acknowledged the key relevance of occupant behaviour, which – depending on the building – may be able to compensate for minor constructional failures, or to trigger dampness and mould problems in well-constructed buildings. It was considered necessary to educate building owners as well as occupants about the impact of their behaviour, and to provide adequate information on the consequences of building changes and renovation activities. Main objectives of any kind of information campaign should be to help the occupants to avoid technical problems and observe good practices (not hanging laundry to dry indoors, open flue heaters, excessive water use in cleaning, excessively low temperatures, misuse of ventilation, etc.). It was recommended that specific advice be given to occupants of problem buildings.

A number of open questions still remain, such as the loose qualification requirements of housing professionals in general and remediation workers in particular, the lack of cost-benefit studies of remediation, the uncertainty about if or when building occupants need to be relocated and the frequent conflict between ventilation and energy-saving requirements. Evidence-based answers to these questions will help improve the actions taken against dampness and mould, and increase the health benefits of the interventions.

Merging all elements from the case studies, the working group put together a generalized summary of actions in relation to specific building-related causes, distinguishing between hygrothermal problems, outdoor and indoor moisture sources and catastrophic events. In addition to actions related to the causes of problems, subsequent actions should adequately address damage already caused, via cleaning or replacement of contaminated materials, drying of wet materials and protecting occupants and construction workers from contaminated materials.

The working group suggested a need for policy guidelines on technical issues, but acknowledged that these can only be very broad and need to be supplemented by specific technical norms and codes of practice on national or regional levels.

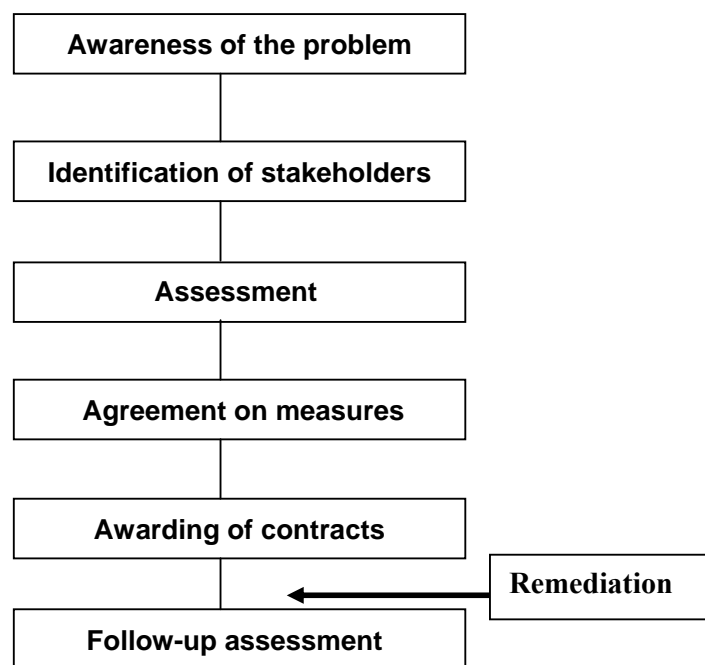
Hygrothermal problems	Remedial action
Increased relative humidity indoors	Addressing indoor moisture sources, control of ventilation and HVAC systems, increasing temperature as necessary
Surface condensation without increased indoor humidity	Addressing thermal insulation, including local thermal bridges and defects
Combined problem	Measures starting with relative humidity indoors
Outdoor sources	Remedial action
Outdoor sources and rising dampness	Diagnosis of moisture path, necessary actions addressing drainage, sealants, water-membranes, flashings, water stops, capillary layers etc. If accessibility is limited and repair works must be done from the inside, consultation with an expert may be recommended.
Indoor sources	Remedial action
Plumbing	Inspection, repairs and replacements
Occupants	Addressing exact moisture source, educating occupants to change occupant behaviour
Catastrophic events	Remedial action
Flooding, storm water intrusion, fire fighting efforts, major water/sewage line breaks, etc.)	Temporary relocation occupants, immediate remedial actions

Working Group 3: Good practice elements and recommendations from process perspective

Chair: Hasselaar; Members: Charpin, Follin, Gallo, Heuberger, Kelly, Kopf, Link, van den Hazel

Working group 3 discussed the case studies from a process viewpoint, considering the actors, mechanisms and institutional context of the actions in the case studies. This group discussed four additional case studies that mainly focused on the mechanisms and processes and suggested strategies for municipalities and/or non-governmental organizations to become involved. The number of case studies discussed was therefore 21.

Drawing from the review discussion of the case studies, the group first developed a “good practice” process example which emerged from the case studies and their individual approaches. As working group 2 was discussing the technical aspects of mould and moisture removal actions, Group 3 did not cover this point and therefore the step of “remediation work” has only been indicated in the process line below. Clearly, not all case studies followed this process and often some steps were not relevant or implemented in a modified way. The good practice example below can therefore be considered a synthesis of steps that were deemed useful and effective. However, it is important to note that the process example described below is based on large-scale remediation requiring professional expertise. A wide variety of other scenarios can be considered in which one or several steps presented below may be left out – one example could be the realization of small and basic repair and remediation work by building occupants, which would ignore the steps of identifying adequate actors and appointing contractors. Depending on the building type and the specific housing market mechanisms, different process lines will be valid.



The group’s first recommendation was of the need for prevention in order to avoid problems in first place. Prevention includes making indoor humidity, ventilation and temperature control focal areas of policy-making.

When problems do arise the mechanisms of the case studies suggest the following steps and actions:

Stage 1: Awareness of the problem

Description	This first stage is the identification of the presence of mould/dampness in a building. It could also be a medical complaint registered by a physician, environmental health or local authority.
Actors or stakeholders involved	<p>Occupants should be provided with information for identifying and preventing mould.</p> <p>National health organizations should provide advice on the symptoms and conditions associated with mould and the preventative measures to be taken.</p> <p>Medical professionals should be made aware of the conditions and symptoms of mould.</p> <p>Facilities managers should be encouraged to act promptly and effectively when a problem is presented. An initial check of the building operations, condition and occupant behaviour should be carried out.</p> <p>Inspectors should identify, as far as possible, the risk factors related to specific complaints, make building occupants aware of them and suggest measures to be taken.</p> <p>Building professionals should provide relevant information on the prevention of mould/dampness to legislative and regulatory bodies.</p>

Stage 2: Identification of stakeholders

Description	<p>The second stage looks at identifying the stakeholders involved in dealing with the complaint. These individuals or organizations should be focussed on identifying the magnitude of the problem, the affected persons and the remedial measures to be considered.</p> <p>All stakeholders should be made aware of the process of intervention, as described here.</p>
Actors or stakeholders involved	<p>Occupants should be made aware of other stakeholders and the next steps in the investigation.</p> <p>Homeowners may be tasked with dealing with mould/dampness issues.</p> <p>Building owners should be aware of problems in their buildings, the processes to follow and the steps involved in interventions.</p> <p>Tenant organizations should be made aware of problems when necessary.</p> <p>Local authorities should take responsibility for following and monitoring the process and make sure adequate solutions are found to protect the residents.</p> <p>Funding agencies who may be able to support inspections should be identified and invited to these discussions.</p> <p>Government agencies may be asked to provide support in cases of financial constraint that could hamper the investigation.</p>

Stage 3: Assessment

Description	<p>Mould/dampness problems should be fully investigated to determine their causes. The assessment can be carried out on medical grounds, building physics investigation and tenant/occupant interview.</p> <p>Guidance can be given to the tenant/owner as to the level of intervention that may be required.</p>
Actors or stakeholders involved	<p>Occupants should be encouraged to clean small areas of mould as an initial step.</p> <p>Building owners should assess the extent of affected areas and determine the need to appoint a dedicated professional.</p> <p>Inspectors should be qualified and trained to a suitable level, as determined by a third-party organization where possible. Guidelines should be provided on how to carry out an investigation in a structured and effective manner. A directory of approved inspectors could be provided to ensure quality.</p> <p>Medical professionals should carry out examinations where a patient referral has been requested. Any diagnosis provided should be presented by specialized professionals.</p> <p>Tenant organizations or local authorities could carry out interviews.</p> <p>Funding agencies relevant to the situation should be involved in these discussions.</p>

Stage 4: Agreement on measures

Description	<p>After the investigation has been completed, remedial measures should be identified and presented to stakeholders for discussion and agreement.</p>
Actors or stakeholders involved	<p>Occupants should be made aware of findings from the inspections and approved remedial measures.</p> <p>Building owners should discuss the findings of the investigation with all other parties involved. They should recognize their limitations and consult with professionals as required. The building owners should recognize their financial role in the remediation process.</p> <p>Inspectors have the primary role of presenting their findings and suggesting remedial work. They should recognize their limitations and consult with other professionals as required. These proposals should be discussed with all parties involved.</p>

Stage 5: Awarding of contracts

Description	<p>When the remedial work has been agreed, a competent contractor who has a good history in work of this kind should be appointed. A clear scope of work should be agreed, including procedures and a contract should be presented for all parties follow. The contractor should be made aware of safe working and handling procedures before work is initiated, and should provide a plan describing how the work will be undertaken so as to minimize risk of further contamination.</p>
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Actors or stakeholders involved

Occupants should be informed of the processes and duration of the remedial work. They have to be protected from exposure to contamination, including relocation under special circumstances

Building owners should provide safe access to the areas.

The building industry is encouraged to provide available technical solutions for remediation work.

Remediation (see Working Group 2)

Stage 6: Follow-up assessment

Description

When the remedial work has been completed, a follow-up assessment should be carried out, including, as a minimum, an inspection of the remedial work, but could also be extended to a medical examination and tenant interview.

A standardized template for questioning tenants should be developed to ensure continuity of approach and measurement of effectiveness.

Actors or stakeholders involved

Occupants should independently request evaluation action.

Building owners should carry out such follow-up actions out of own interest.

Local authorities should monitor the success of remediation for public buildings and possibly expand this to (or initiate the process for) private buildings.

Remediators and inspectors should take interest in evaluating their work and performing adequate measures for quality control.

Medical professionals can use health survey and research methods to assess the effect of remediation.

Meeting conclusions

From the final discussions and comments of the working groups, based on their prior discussions, the following main conclusions on technical actions and policy implications were derived:

Technical actions and interventions against dampness and mould

There is more evidence available than that found in the case studies discussed. Although the case studies provide an impression of how theoretical knowledge on dampness and mould interventions can be carried out in practice, they also provide restrictions as they do not reflect the full scope of potential actions and interventions. Therefore, for further progress of the project, additional review activities of actions and projects are recommended.

Adequate assessment of the magnitude of the problem, as well as a thorough identification of the root causes of damp, moisture or mould occurrence, are considered the key measures for sustainable remediation and prevention. This includes not only building parameters, but also the occupants' behaviour.

The physical removal of mould and mould-affected materials is considered the main strategy for remediation and various case studies have proven its effectiveness. However, the exact measures strongly depend on the given problem and building. There was consensus among the participants that although complete removal and remediation is desirable, focused remedial action targeting the main problems can be a successful first measure as well.

The balance between moisture, air change rate and surface temperatures (both indoor surfaces as well as surfaces within the building structure) has been identified as the main objective for both remediation and preventative measures. Therefore, applicable and affordable solutions are needed to either reach such balanced conditions in damaged buildings, or prevent unbalanced conditions in general terms. Assuming that buildings are healthy in most situations, the preventative dimension of this balance is a key objective for technical actions.

As the case studies were strongly focused on the remediation of existing problems, the actions undertaken did not provide direct information on the value of preventive approaches. Nevertheless, actions taken to ensure that conditions do not reappear after removal help to reach balanced indoor conditions in relation to dampness, ventilation and temperature.

Policy dimensions of the case study review

To eliminate subsequent problems from dampness and mould, preventive measures must be intensified already from the design and construction of new buildings. This is particularly relevant in combination with measures to reduce energy consumption. The meeting participants strongly felt that for a variety of conditions and parameters, such as a threshold level for relative humidity or thermal insulation values, national and international guidelines and standards need to be developed. However, technical guidance on exact values may be more appropriate on the national level, adapted to the pertinent climatic and building characteristics. International work could rather be focused on the overall content and requirements for such guidance, leaving the practical implementation to the country level. The development of WHO Indoor Air Quality Guidelines for Dampness and Mould was considered the appropriate process for suggesting such guidance tools and values.

One key component that is currently missing in the protection of the population is the lack of mould monitoring and identification of exposure problems in private homes. While there are clear mandates of local authorities and regular assessments and inspections for publicly owned buildings, there is no public responsibility for private homes. In the rental sector, however, there is a clear responsibility of building owners to provide adequate housing conditions, but in practice this is mostly restricted to legal implications after a problem has been identified, and very little is done of a preventative nature. Future policies need to improve this situation, and enable private residents to identify problems and act accordingly. This also includes the provision of quality control measures for remediation work, which can usually not be assessed and evaluated by residents.

As main options to protect the health of private residents, the meeting suggested increased involvement of municipal services and implementation of inspections in relation to new rental or purchase contracts. In addition to such general approaches, there could be identification of buildings with specific dampness and mould problems. In most countries, there is sufficient knowledge on the quality problems of the housing stock to allow for national campaigns – possibly supported by grants and incentives – to address those buildings as a first priority.

Parallel to approaches targeting specific elements of the housing stock, the education of housing practitioners and craftsmen is relevant. As professionals involved in building work and rehabilitation have direct access to the building, they could, with proper training, become a major factor in the protecting the population. In addition to the identifying problems (which may be unknown to the occupants), such housing practitioners could also inform and advise occupants about adequate action. Additionally, the building industry is encouraged to take part in the development of practical solutions for remediation work.

From a policy perspective, little is known about the regulations and policies on handling dampness and mould and their elimination in different countries. A review of policies and regulations would be helpful to compile national practices and approaches, and would provide suitable background information for the development of policy recommendations.

Finally, and with much emphasis, the meeting participants concluded that policy approaches need to address both buildings and occupants, and especially empower the occupants to identify problems and take appropriate action. However, this requires increased awareness of the problem as a first measure, as well as basic awareness of the technical relationship between humidity, temperature and ventilation by the residents. It was suggested that information campaigns be less focused on mould – which is rather a symptom, not a cause – and instead send a clear message that the ultimate problem is excessive dampness, moisture and condensation. This would help to avoid activities undertaken by private actors with the objective of removing mould (sometimes using hazardous chemical substances to do so), and redirect the actions to address the root causes of dampness and moisture.

Project perspectives

Reviewing case studies on interventions against dampness and mould is one element of a larger project addressing the policy implications of actions to reduce health risks due to indoor air pollution with biological agents. Complimenting the development of indoor air quality guidelines on dampness and mould, this project aims at delivering policy advice on adequate tools, actions and mechanisms. Therefore, the conclusions and recommendations developed at this meeting will provide one of the background documents for a future project meeting focusing on the development of policy briefs, informing policy-makers about the main challenges, appropriate actions and adequate policies to prevent, mitigate and reduce the exposure of the population. The recommendations in this meeting were directed to the general population. The consideration of people with special needs or with special risks should be done in a further step.

In addition to the policy meeting, additional work will have to be carried out to identify evidence for both technical and policy measures against dampness and mould. Working steps should aim at providing information on areas identified as insufficiently covered by the review of case studies and technical actions. Main elements of future work as a preparatory step for a policy meeting could include:

- compilation of technical and case studies from southern Europe and warmer climates
- review of measures undertaken in public or institutional settings
- review of projects, standards and guidelines related to policy approaches to prevention and mitigation.

Based on the conclusions of the case study review and some additional background documents, the policy meeting would then gather a number of European experts and policy-makers to discuss appropriate interventions and their translation into political action and policy tools.

Annex 1: Case study summary

WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR EUROPE



WELTGESUNDHEITSORGANISATION
REGIONALBÜRO FÜR EUROPA

ORGANISATION MONDIALE DE LA SANTÉ
BUREAU RÉGIONAL DE L'EUROPE

ВСЕМИРНАЯ ОРГАНИЗАЦИЯ ЗДРАВООХРАНЕНИЯ
ЕВРОПЕЙСКОЕ РЕГИОНАЛЬНОЕ БЮРО

WHO expert meeting on interventions to reduce health effects of dampness and mould

Bonn, Germany, 28 - 29 February 2008

Case study summary

Contents

General information about received studies	19
Methodology of case study selection	19
Description of the case studies	20
Review of selected case studies	27
1) Main elements: Interventions, exposure assessment and health impact	27
2) Settings for dampness and mould interventions	28
3) Actors and project contexts	29
4) Measurements of exposure or health in the studies	29
5) Selection of the study population	30
6) Adverse health effects of remediation activities	30
Table 1: Results of the review process	32

Produced by:
WHO Collaborating Centre for Housing and Health
Dr. Iris Kompauer

General information about received studies

In total, 30 case studies on dampness and mould interventions were submitted to the WHO European Centre for Environment and Health, Bonn Office. Countries of origin were Belgium (4 studies), Denmark (1), Finland (4), France (1), Germany (6), Israel (3), New Zealand (1), Slovakia (1), Sweden (4), the United Kingdom (3) and the United States (2). Twenty of these studies were conducted in residential buildings, four in schools, one in residential buildings and schools, one in a child centre, one in a child centre and residential buildings, one in an elderly centre, one in an office building and one (an information campaign) targeted all kinds of buildings. Seventeen were intervention studies, seven information campaigns, one was a laboratory experiment and five were miscellaneous activities.

Methodology of case study selection

Case studies were evaluated by the WHO Collaborating Centre for Housing and Health, according to criteria for intervention studies on mould remediation established by the Centre (Drs Gabrio, Kompauer, Link) together with Dr Szewzyk. In parallel, each of the four members of the advisory group evaluated 15 studies for eligibility for the WHO expert meeting on interventions to reduce health effects from dampness and mould. The studies were categorized as: useful for discussion, limited but still useful and those selected by each reviewer. Finally, all rankings were merged, with 17 studies reaching at least a 2 in the overall ranking considered appropriate for further discussion. The other 13 studies were not considered for the meeting mainly for the following reasons:

- no intervention study / before-after design
- out of scope
- weak practical evidence
- no systematic evaluation.

The results of this review process are summarised in Table 1 at the end of this document.

Description of the case studies

On the following pages the interventions and, where available, measured exposures and health outcomes of the 17 studies are summarized. For this summary, the submitted case study descriptions and additional publications or drafts for publication were considered.

Lorenz et al. (Germany) (3) gave advice on mould remediation for 249 residents of 114 residential buildings and 6 months later investigated by a telephone interview if the damage had been repaired and if the ailments of the inhabitants had decreased following renovation. After removal or after renovation of all damage with complete removal of the damaged material, roughly 87% reported amelioration of the respiratory and skin symptoms and in 73% and 47%, respectively, the joint pain decreased or disappeared completely. After repair of all damage without removal of the damaged material, 39% of the previously suffering people reported amelioration of respiratory and skin symptoms and 20% a decrease or disappearance of joint pain. After repair of only a part of the mould damage with complete removal of the damaged material, 74% reported amelioration of respiratory and skin symptoms and 54% a decrease or disappearance of joint pain. Without repair, 17% of the previously suffering people reported amelioration of the respiratory and skin symptoms and 19% a decrease or disappearance of joint pain.

In **Dearborn et al. (United States) (4)**, interventions were directed at reducing water infiltration, removal of water-damaged building materials and altering heating, ventilation and air conditioning units and environmental cleaning in the houses of 62 moderately severe asthmatic children or families with young infants where there was visible water damage and/or a mould source. In the control group only house cleaning information was given. In total, 104 residential buildings were included in this study. Children in both groups showed improvement in asthma symptomatic days during the pre-remedial period of the study. The remediation group had a significant decrease in symptom days ($p = 0.003$, as randomized; $p = 0.004$, intent to treat) after remodelling, whereas these parameters did not significantly change in the control group. In the post-remediation period, the remediation group had a lower rate of exacerbations compared to control asthmatics (as treated: 1 of 29 vs. 11 of 33, respectively, $p = 0.003$; intent to treat: 28.1% and 10.0%, respectively, $p = 0.11$).

Wilson et al. (United States) (7) distributed a video providing guidance on flood clean-up and mould control for houses in an urban area (New Orleans) affected by multiple days of flooding after Hurricane Katrina. Preliminarily, they conducted a very well-documented pilot study in three single-family houses. The intervention included disposal of damaged furnishings and drywall, cleaning surfaces, drying the remaining structure and treatment with a biostatic agent. Before the intervention, they measured culturable fungi, fungal spores, PCR and endotoxin in indoor air in all three houses; fungal spores in indoor and outdoor air at all three houses; culturable fungi, PCR, and endotoxin in outdoor air at one house and moisture content of the

wood studs. Additionally, they visually inspected the extent of mould on walls, cabinets, floors, doors, trim, appliances, equipment and ductwork. After the intervention, they measured culturable fungi, PCR and endotoxin in indoor and outdoor air at all houses and fungal spores in indoor and outdoor air at one house. The intervention resulted in a reduction of very high concentration of colony-forming units and spore counts and (except for one house) endotoxin levels. The authors reported an underestimation of some species in culture-based analyses. Average workplace protection factor against fungal spores for elastomeric respirators was higher than for the N-95 respirators. The authors found that intensive dry cleaning followed by the application of borates appears to control mould growth. Unfortunately, no health outcomes were measured.

In epidemiological studies, **Herbarth et al. (Germany) (8)** wanted to find out changes in load depending on activities like remodelling or mould removal and associated health effects in approximately 3000 dwellings and 50 child centres with approximately 6200 people. In the cohort studies, at every time of investigation (around birth, after 7 weeks, 0.5 years old, 1 year old and at every birthday until the 6th, 10th or 14th), volatile organic compounds (VOC) and microbial volatile organic compounds (MVOC) were measured using passive (4 weeks) and active sampling methods. The mould was measured using sampling devices (and agar plates). Lifetime prevalence of physician-diagnosed eczema and allergy-associated symptoms were assessed by questionnaire. In the repeated cross sectional studies the authors found a strong link between renovation activities around birth and incidence of atopic diseases in later life. The risk was approximately two times higher than in the control group (no renovation). The earlier in a child's life renovations were carried out, the greater the risk of developing allergic disorders later on.

In the second contribution by **Herbarth et al. (26)**, based on the results of measurements in approximately 500 apartments, the subjects were given information about reducing or removing mould with reference to the “Mould remediation guide” [*Schimmelpilzsanierungs-Leitfaden*]. No measures were prescribed with consideration to legal problems. Before and after the intervention, indoor mould spores and VOC were measured. Allergic disorders, airway diseases and indoor associated syndromes like sick building syndrome or chronic fatigue syndrome were assessed by questionnaire, specific immunoglobulin E (IgE) and immunoglobulin G (IgG) were measured. The following measures were undertaken conducted by the participants or owners of the apartments: mould remediation by a specialized company; mould remediation by the participant using anti-mould chemicals and/or remodelling; changing apartments or doing nothing. The measures are not described in detail (the chemicals used, etc.). For all participants who had taken any measure the load caused by mould was lower than before or not further detectable. Preliminary results suggest that typical indoor mould spores such as *Penicillium* (-30%) and *Aspergillus* (-70%) were reduced, and this is reflected in symptom load reductions. This effect was observed with regard to non-specific symptoms like headache or fatigue as well as specific symptoms of the respiratory tract (irritation, itching nose, cough), epidermis and eyes

(irritation, dry eyes, skin rash). All in all the number of affected persons was decreased by 15–30%. Changes of laboratory parameters were also observed (generally improving), for example specific IgE and IgG. The improvement in symptoms was more pronounced than that in the laboratory parameters.

Haverinen-Shaughnessy et al. (Finland) forwarded four studies (10, 11, 28, 29). In their first study (11), they conducted improvements in drainage, rainwater sewer systems and water barriers of basement walls in a school. Additionally, replacement of moisture-prone materials improperly used in locations subjected to high moisture loads, improvement in ventilation of crawl spaces and replacement of all damaged material was done. Areas where damage was observed were left unused and isolated to avoid air exchange between the damaged areas and other areas before and during the repairs. An extensive cleaning after the removal of damaged materials included wiping of all surfaces and disinfecting materials prone to microbial contamination. The data were analyzed both in cross-sectional design including all respondents, and longitudinally including paired observations of those individuals who had responded both before and after the repairs. After the repairs there was significant improvement of most of the 20 symptoms studied among the cross-sectional study populations. However, improvement was not so clear in the paired analysis and generalized estimating equation (GEE) analysis among the students who responded to three repeated questionnaires. The results indicate that the repairs succeeded in the sense that new cases of symptomatic students were no longer expected. Both technical and microbial follow-up measurements made after one year and partially repeated at three years suggested that the repairs were satisfactory and microbial contaminant levels were reduced.

In a second study, **Haverinen-Shaughnessy et al. (10)** followed-up effects of remediation (including renewal of roofing, improved drainage system, remediation of balconies and renewal of damaged ceiling tiles) in an elderly centre. Before and after the intervention, they measured surface moisture and temperature, as well as culturable (and non-culturable) fungi from air, surface and bulk samples. After the intervention they measured culturable and non-culturable fungi in air. The employees responded to a health questionnaire based on Örebro-Questionnaire (MM40) and the Tuohilampi questionnaire, and also kept a symptom diary during the process. The health questionnaire included 70 questions on irritation, respiratory and general symptoms, respiratory infections, acute and chronic respiratory diseases and allergic diseases as well as questions on changes observed between the questionnaires. After remediation, water leakage through roof and balcony structures had stopped, and no more *Stachybotrys spp.* fungi was observed in the indoor air samples. However, low concentrations of other indicator microbes were still observed. Occupants reported significantly fewer nasal symptoms, hoarseness, sore throat, and eye symptoms. Symptom association with work decreased significantly for facial eczema and cough. The prevalence of sinusitis was significantly decreased after the remediation.

In the third study on a row house complex including 51 apartments with 145 residents (28), **Haverinen-Shaughnessy et al.** recommended the improvement of ventilation and drainage,

drying of wet materials and improving moisture protection in bathrooms. Before and after the intervention, surface moisture, temperature, CO₂-concentration, pressure differences, air flow measurements were performed. Only technical evaluation was done in the course of the study. Microbial and health effects studies were also included in the process, but the results have not been analyzed collectively due to the research project ending. The technical monitoring indicated improved and more controlled ventilation. However, some of the floor structures still had elevated moisture content. Occupant reports and complaints of poor IAQ had diminished. This data was not systematically collected, but was based on assessment by the environmental health officers of the city records of occupants' spontaneous contacts.

The fourth **Haverinen-Shaughnessy et al.** study (29) was conducted in a school and consisted of ventilation system improvements and roofing renewal, air leakage sealing, windows repair, drainage improvements and remediation of wooden ground floor structures. Before the intervention, culturable and non-culturable fungi from air, surface and bulk samples were measured. Technical follow-up measurements included visual observation, and measurements of relative humidity and temperature from structures. Culturable and non-culturable fungi in air, and culturable fungi from surface or bulk samples were measured yearly during the three years of the remediation. In the follow-up phase annual questionnaires were given to the personnel, based on Örebro-Questionnaire (MM40) and the Tuohilampi questionnaire, including 70 questions on irritation, respiratory and general symptoms, respiratory infections, acute and chronic respiratory diseases and allergic diseases. Additionally, questions on changes observed in between the questionnaires were asked. Students responded to a similar questionnaire, including 44 questions on respiratory and general health, 12 questions on background information and 16 questions about the school. Repairs could not be implemented immediately due to budgetary constraints and were extended over three years. Large spatial and temporal variations were observed in the airborne microbial concentrations. Hence, no conclusion could be drawn based on these results. Occupant health status remained similar or even deteriorated during the remediation process. Therefore, the remediation did not have positive effects on occupant health.

Becker R et al. (Israel) (13) established adequate minimal thermal insulation requirements in new Israeli dwellings to reduce the risk of surface condensation in bedrooms and living rooms in regular size dwellings under normal use conditions, surveying 250 dwellings before implementation of the standards and 100 (different) dwellings after implementation. The first survey indicated that only 45.5% of the dwellings had no condensation-related mould growth; 19% had severe mould growth attributed to surface condensation and 29.5% had observed surface moisture due to condensation. After implementing the new standard, the level of condensation-related mould growth was reduced to less than 30% and severe mould growth related to surface condensation to less than 9%, appearing only in dwellings in the north of the country with an insulation level almost equal to the new minimum.

Oreszczyń T et al. (United Kingdom) (15) reported installation of draught stripping, thermal insulation and gas central heating systems in roughly 3000 low-income residences. Before and after the intervention, living room and main bedroom temperatures and relative humidity were measured. Additionally, visual inspections of the occurrence and extent of mould were done and quantified on a mould severity index (MSI). The authors found that standardized relative humidity increased with the size of the household and that there was a clear relationship between standardized relative humidity and presence of mould. The risk of mould is very small if the standardized relative humidity is below 40%. Overall, the project was successful in increasing thermal comfort and indoor temperatures while humidity and mould problems were reduced.

Emenius et al. (Sweden) (16) measured air change rates, indoor air humidity, mite allergen levels in mattress dust and total VOCs in 59 one-storey single-dwelling houses to study the impact of mechanical ventilation on various indoor parameters. In 22 out of the 59 houses a balanced mechanical ventilation system was installed; the others had the originally installed natural ventilation (29) or improved natural ventilation (8). Increased indoor air humidity ≥ 7 g/kg air was only observed in naturally ventilated houses (8 of 29). The authors found an inverse correlation between the air exchange rate per hour and absolute indoor humidity ($r=-0.64$) and a weak inverse correlation between air exchange rate per hour and mite allergen in mattress dust ($r=-0.31$). No significant correlation between indoor humidity levels and mite allergen in mattress dust, but significantly lower levels of mite allergen in mattress dust and concentrations of VOC in mechanically ventilated houses was reported by the authors. Absolute humidity levels were significantly lower than in a previous study, likely due to different times of year (October vs. March).

Matthews et al. (United Kingdom) (17) conducted a randomized controlled trial on houses of patients with asthma consisting of 81 intervention and 83 control houses. The intervention included removal of indoor mould, application of fungicide and installation of exhaust fans in lofts. Before the intervention, air temperature and relative humidity, ergosterol in air samples, outdoor mould and house dust mites were measured, and mould presence was confirmed by trained observers. After 12 months, measurement of air temperature and relative humidity was conducted again and mould was visually inspected. After 6 and 12 months, morning and evening peak expiratory flow (PEF) variability declined in both the intervention and the control groups, with no significant differences between them. Also, an improvement in wheezing, rhinitis, rhinoconjunctivitis and a reduction in medication use were observed in the intervention group. The reduction in humidity was small but significant. Visible indoor mould was eradicated in all houses in the intervention group, but 12 months later it had reappeared in 40% of them, mostly at new sites. Some residents of the control houses also took their own actions to remove mould, so that by 12 months mould was present only in 78% of them.

Activities of the WHO housing programme reported by **Braubach et al. (Germany) (19)** included the assessment of thermal insulation of facades, building roofs and basement ceilings, replacement of single-glazed with double-glazed insulation windows, exchange of doors to

staircases and exchange of the heating system in some dwellings. The intervention group consisted of 212 residential buildings, the control group of 162. After the intervention, data on indoor temperature and relative humidity for 189 dwellings, dust samples for 102 dwellings, VOC measurements for 22 dwellings and measurement of inside and outside wall temperature and humidity for bedrooms and living rooms for all dwellings were collected. Peak flow and NO in exhaled air were measured and prevalence of selected diseases was assessed by questionnaire. The residents of the intervention dwellings reported greater thermal comfort. Indoor temperatures were higher and relative humidity was slightly reduced in the intervention dwellings, compared to the control dwellings. For visible mould growth, very little change was found a few months after the intervention. For several diseases (asthma, cold, bronchitis), the prevalence increased for residents of control dwellings while there was no change or a slight decrease for intervention dwelling residents. Stronger results were found for the number of acute respiratory diseases during the last three months (i.e., winter), which increased for the control group and decreased for intervention group.

The intervention of **Bladt et al. (Belgium) (21)** consists of an environmental diagnosis of a dwelling where indoor exposure to mould, other organic substances or chemicals pollutants is suspected to contribute to reported health problems. Reports were sent to physicians, who would advise subjects and then assess their health after 12–18 months. Starting in 2000, the programme was conducted for approximately 150 dwellings each year, with chemical (VOCs, benzene, toluene, xylene, formaldehyde and pesticides) and biological sampling (mould contamination of surfaces and air and dust mite allergens) of each room. The diagnoses include a search for sources (bad ventilation, condensation, humidity, building problems). A questionnaire on health improvement was sent to every patient and doctor. After 12–18 months, 57% of physicians reported real improvements in patient health and 80% of the patients felt an improvement in their health. In 30% of cases, the doctors' advice had not been implemented by the respondents.

The intervention of **Howden-Chapman et al. (New Zealand) (22)** consisted of ceiling insulation in 1400 dwellings with approximately 5000 residents, draught stopping around doors and windows, under-floor insulation and under-floor polythene to reduce rising moisture, as appropriate. Before and after the study, indoor temperature, energy consumption and relative humidity were measured. Additionally, speciation and mass of mould, endotoxins, beta-glucans and dust mite allergens were measured, but not reported. Data on self-reported health, wheezing, school and work sick days, visits to general practitioners and admissions to hospital were collected using a questionnaire. The insulation caused a small increase in bedroom winter temperatures (0.5°C) and a decrease in relative humidity (–2.3%), exposure to temperatures below 10°C was reduced by 30%. Fair or poor self-rated health, self-reported wheezing in the last three months, self-reported school and work absence were reduced. GP visits and hospital admissions for respiratory conditions were less often reported by occupants of insulated buildings.

The study of **Pieckova et al. (Slovakia) (25)** included a public information campaign on avoiding objectively identified factors that increase indoor dampness and mould. The authors compared 148 dwellings and 3 schools of the same construction type in the same area with (cases) or without (controls) complaints about dampness and mould. At the beginning of the study, construction type, indoor temperature including dew point and surface temperature were measured. Information on household style (ventilation, cleaning regimen, internal sources of dampness, furnishings, economic status, subjective health conditions – respiratory illnesses, discomfort etc.) were collected using a questionnaire. Very early results (half a year after the information campaign) include a reduction of complaints about indoor dampness/moulds (further statistical validation needed) in dwellings. Statistical analysis of the relationships of indoor fungal contamination to hygrometric conditions, household characteristics and construction defects is in process. The inhabitants of mould-affected buildings mostly behaved differently in terms of heating/ventilation modes, cleaning and maintenance practices and indoor moisture sources, factors that seem to affect indoor moulds even more than construction or insulation failures.

Review of selected case studies

1) Main elements: interventions, exposure assessment and health impacts

I. Actions and interventions to prevent, remove or mitigate dampness and mould

Mould removal

- removal of indoor mould
- appliance of fungicide
- replacement of all damaged material

Change of ventilation

- installation of a fan
- exhaust ventilation system
- improved ventilation in crawl spaces

Reduction of water infiltration

- ceiling and roof repairs
- under-floor polythene
- drainage improvements
- rainwater sewer systems
- water barriers for basement walls
- replacement of moisture-prone materials in high-moisture locations

Thermal insulation

- under-floor insulation
- thermal insulation of facades, roofs and basement ceilings
- replacement of single-glazed with double-glazed windows
- draught stopping around doors and windows
- heating system replacement

Further activities

- remediation of wooden ground floor structures
- isolation of affected areas to avoid air exchange before and during the repairs
- extensive cleaning after removal of damaged materials, including wiping of all surfaces and disinfecting materials prone to microbial contamination.

II. Exposure assessment

To assess the exposition before and after interventions, data on the following risk factors were collected:

- dampness and relative or absolute humidity measured by the study or reported by residents
- visible mould determined by the researchers or reported by the residents
- dampness or mould determined by the researchers or reported by residents
- spore microscopy and/or polymerase chain reaction (PCR) to identify fungi

- concentrations of mould spores and culturable fungi
- related microbial agents

III. Health impact assessment

By medical examination

- Spirometry for forced expiratory volume in one second (FEV₁), forced vital capacity (FVC), peak expiratory flow rate (PEFR)
- NO in exhaled air
- skin prick test, total IgE, specific IgE, IgG
- peripheral blood eosinophil counts

By questionnaire

- prevalence of allergic, respiratory and other diseases
- indoor-associated syndromes like sick building syndrome or chronic fatigue syndrome
- general symptoms, health
- use of medication
- amelioration of ailments
- quality of life.

2) Settings for dampness and mould interventions

Twelve of the studies were conducted exclusively on residential buildings, two exclusively on one school building each and one on an elderly centre. One study included residential buildings and schools, one residential buildings and child centres (8). The numbers of investigated residential buildings ranged from 3 single-family houses in the pilot study on mould removal after hurricane Katrina (7) to approximately 3000 in the studies of Herbarth et al. (8) and Oreszczyn et al. (15). The DVD on the mould removal campaign after hurricane Katrina was also distributed to at least 3000 residents of the affected buildings, but this was not evaluated further.

Unfortunately, the results for the 50 child centres that were mentioned by Herbarth et al. (8) were not listed separately. In the elderly centre (10), mainly the outer parts of the building were renovated or repaired (roofing, drainage system, balconies and damaged ceiling tiles), other possible damage sites within the building were not included. This partial measure stopped water leakage and improved microbial status of the building and occupant health as assessed by questionnaire. However, because of the very limited information on child and elderly centres, conclusions on these institutional settings can hardly be drawn.

3) Actors and project contexts

Eight were conducted by universities, four by a public health institute, one by WHO, one was an initiative of an environment ministry and the remainder were from other institutes or consumer initiatives. The studies mainly had research objectives; only four mainly aimed at pragmatic improvement of indoor conditions for the good of the residents. In one project, a research group primarily conducted a study on mould removal in highly affected buildings (three houses in New Orleans after Hurricane Katrina) to produce a DVD for a mould removal campaign.

4) Measurements of exposure or health in the studies

Nine of the studies measured indoor mould concentrations before and after the intervention, mostly in the air and surfaces of building materials. Other compounds or metabolites of microorganisms measured were endotoxins, beta-glucan, ergosterol and volatile organic compounds. All studies that analysed the differences between concentrations of mould and compounds of microorganisms found a reduction or complete disappearance after the interventions.

Eight studies measured moisture in the air and on building surfaces. In the limited number of studies where the changes in humidity after the intervention were reported, there was at least a small reduction of moisture. Interventions conducted to reduce humidity were mainly changes in ventilation, reduction of water infiltration and thermal insulation. Oreszczyzn et al. (15) improved insulation and heating systems in low-income households, leading to a reduction in relative humidity and mould growth. Also, thermal insulation resulted in a reduction of condensation-related mould growth in the study of Becker et al. (13). In the studies of Braubach (19) and Howden-Chapman et al. (22), relative humidity was also reduced by thermal insulation. Installation of a fan in the loft resulted in a significant reduction of humidity in the intervention houses 12 month later. Comparing mechanically ventilated vs. naturally ventilated houses, Emenius et al. reported that high indoor air humidity (≥ 7 g/kg air) was only found in naturally ventilated houses and that there was an inverse correlation between air exchange rate per hour and absolute indoor humidity ($r=-0.64$). Reduction of water infiltration by repairing or exchanging building structure was also successful in the studies.

To summarize these results, each of the single methods to reduce humidity seems to be successful, but it is not clear which of these measures is the best to resolve the problem or whether a combination of improved ventilation and thermal insulation is much better than applying only one of these measures.

In health status reporting, all studies found an improvement of symptoms after the intervention (it is not possible to assess publication or contribution biases). However, in some studies questionnaires were handed out to the participants both before and after the intervention and differences in health outcomes were assessed, whereas some studies only asked if symptoms had

improved after remediation. The latter technique is most likely less valid for assessing health status because of the possibility of a placebo effect. Generally, it is not possible to blind the residents to the intervention; they inevitably know if mould has been removed and if actions to reduce dampness have been taken, and might feel better only because they see that the condition of their dwelling has improved.

Medical examinations were less frequently implemented than questionnaires on health status. In six studies (4, 8, 17, 19, 26, 28) the authors stated that they conducted medical examinations, but the results were presented in only three of them. In their case-control study, Dearborn and Kercksmar reported better measurements of pulmonary function (FVC, FEV₁, PEF) six months after the remediation in the remediation group, but no differences at the beginning of the study and after 12 months in a limited number of study participants (n=33). Levels of total IgE or total eosinophil counts did not change between the first and the last clinical visits in either group. Matthews et al. (17) found a decline in the PEF both in the intervention and in the control group after the intervention, but no differences between the groups. Herbarth et al. (26) wrote that “together with the symptoms also changes of laboratory parameters have been observed (as a rule an improvement), for example specific IgE, IgG. The improvement in case of symptoms was more pronounced than in the laboratory parameters.”

From these limited results on medical and laboratory examinations conclusions can hardly be reached. Generally, if effect sizes of health improvement were measured, they were greater for self-reported data than for the results of medical examinations.

5) Selection of the study population

Two studies included only asthmatic children (4, 17), whereas one study (16) excluded people suffering from allergic diseases on the grounds that they could take other allergen-avoidance measures than changing the ventilation system. Two studies were conducted with people suffering from health complaints suspected by physicians to be related to indoor exposure (3, 21). In the latter studies, improvement of health status was asked 6 and 12–18 months after the remediation activities had finished. However, the physicians' suspicion that indoor exposure might have been a cause and patients' assumptions that remediation activities themselves might cause amelioration could have induced placebo effects.

6) Adverse health effects of remediation activities

In the study of Herbarth et al. (8) a strong link between exposure to renovation activities in early life and incidence of atopic diseases in later life was found. The risk of illness was approximately twice as high in such cases as in the control group. The Odds Ratio for allergic symptoms was 1.85 (1.31-2.61; p=0.0004) and for eczema 1.95 (1.43-2.67; p<0.0001). The prevalence of allergic symptoms was 9.3% without renovation and 16.8% after all three renovation activities.

Consistently, the prevalence of eczema was 11.5% without renovation and 20.3% after all three activities. The authors concluded that the earlier in a child's life renovations were carried out, the greater the risk of developing allergic disorders later on. Unfortunately, mould was not investigated in that study. A preliminary study on the respiratory health of children during remediation activities after hurricane Katrina conducted in February/March 2006 showed an increase in the proportion of children with symptoms and a lower limit of normal lung function, compared to before the hurricane and after the remediation activities finished in April/May. Most families in that study had limited flood damage, and half of them reported having renovated their residence. Indoor mould levels were not significantly associated with symptoms, and therefore the authors concluded that “exposure to other respiratory irritants could be a factor triggering symptoms”. However, the authors also considered that winter colds and exposure to rotting debris, diesel exhaust or other factors outside might have elicited the respiratory symptoms (Rabito et al., *Journal of Allergy and Clinical Immunology*, 2008). Haverinen-Shaughnessy et al. (29) reported that occupant health status in a school remained similar or even deteriorated during the remediation process, which lasted for three years. The authors remarked that the remediation did not have positive effects on occupant health. In a study on an elderly centre (19) the same author reported that personnel expressed concerns about the health of the elderly people during the remediation.

Because several measures were conducted in parallel in these studies, the impact of any single measure on health outcomes cannot be assessed.

Table 1: Results of the review

Nr	Country	Title	Overall result	Selected for discussion
1	Denmark	Climate chamber damaged buildings	3.00	
2	Sweden	Day care centre mould removal Sweden	2.33	
3	Germany	Dwelling mould removal NRW Germany	1.33	X
4	USA	Dwelling mould removal USA	1.00	X
5	Belgium	Housing inventory list Flemish Government	3.00	
6	Germany	Mould remediation education Germany	2.66	
7	USA	Mould removal campaign Katrina USA	2.00	X
8	International	Mould studies International	1.33	X
9	Israel	Mould-resistant paints Israel	3.00	
10	Finland	Remediation in elderly homes Finland	1.33	X
11	Finland	School moisture damage repair work Finland	1.00	X
12	Sweden	Sick building offices Sweden	2.66	
13	Israel	Thermal insulation standard change Israel	2.00	X
14	Belgium	Ventilation measures Belgium	3.00	
15	UK	Warm Front thermal housing improvement UK	1.33	X
16	Sweden	Dwelling ventilation changes Sweden	1.66	X
17	Wales/UK	Dwellings mould eradication Wales	1.00	X
18	Sweden	Dwellings mould removal Sweden	2.66	
19	Germany	Dwellings thermal insulation Germany	1.00	X
20	France	Dwelling environmental inspection and counselling France	2.33	
21	Belgium	Green ambulance Belgium	1.66	X
22	NZ	Housing insulation effects New Zealand	1.00	X
23	Belgium	IAQ and health tool Belgium	2.66	
24	Germany	Mould consultation and mediation Germany	2.66	
25	Slovakia	Mould problems in dwellings and schools Slovakia	1.66	X
26	Germany	Mould removal dwellings Leipzig	1.66	X
27	UK	Purifan air cleaning system in schools UK	2.66	
28	Finland	Remediation in dwellings Finland	1.33	X
29	Finland	Remediation in schools Finland	1.33	X
30	Israel	Ventilation system change Israel	3.00	

NOTE:

The case studies discussed during the meeting can be accessed at
http://www.euro.who.int/Housing/support/20080403_1

Annex 2: List of participants

Temporary Adviser

Rachel Becker Technion - Israel Institute of Technology	Israel
Viktorija Buzyte State Environmental Health Centre	Lithuania
Denis Charpin Department of chest disease and allergy Service de pneumologie-allergologie, Hôpital Nord, Marseille	France
Mike Davies Bartlett School of Graduate Studies Faculty of the Built Environment University College of London	United Kingdom
Gunnel Emenius Occupational and Environmental Health Unit of Environmental Medicine Stockholm Center for Public Health	Sweden
Tom Follin Byggmiljögruppen	Sweden
Evert Hasselaar OTB Research Institute Delft University of Technology	Netherlands
Ulla Haverinen-Shaughnessy Department of Environmental Health National Public Health Institute (KTL)	Finland
Wolfgang Hofbauer Fraunhofer Institut für Bauphysik	Germany
David Kelly Building Research Establishment	United Kingdom

Laura Kolb Indoor Environments Division US EPA	United States of America
Iris Kompauer State Health Office Baden-Württemberg	Germany
Marle Kopf Umweltberatung Verbraucherzentrale NRW	Germany
Jarek Kurnitski HVAC-Laboratory Helsinki University of Technology	Finland
Bernhard Link WHO CC for Housing and Health Regierungspräsidium Stuttgart Landesgesundheitsamt Baden-Württemberg	Germany
Lars Molhave Department of Public Health University of Aarhus	Denmark
Katarina Slotova Regional Authority of Public Health	Slovakia
Peter van der Hazel Hulpverlening Gelderland Midden	Netherlands
Joris van Loenhout Hulpverlening Gelderland Midden	Netherlands
Jolanta Walusiak Institute of Occupational Medicine	Poland

Observer

Jörg Bogs
Isotec
Germany

Giulio Gallo
DG Sanco, Unit 4
European Commission
Luxembourg

Imke Thieme
Prevention, Environment and Health
Federal Ministry of Health
Germany

Birgit Wolz
Environment, Health and Consumer Protection
Federal Environment Ministry
Germany

World Health Organization

Regional Office for Europe

Michal Krzyzanowski
Matthias Braubach

Secretariat

Andrea Rhein-Hubert

Intern

Matthias Heuberger

Meeting report: Policy recommendations on interventions and actions against dampness and mould. 9-10 February, 2009.

Context and objectives of the meeting

The exposure to biological agents in indoor environments is a significant health hazard, causing a wide range of adverse effects on health. The presence of such biological agents as mould in the indoor air is attributable to housing characteristics, particularly dampness, condensation, inadequate ventilation and structural failures, as well as to inadequate behaviour of occupants in relation to heating, ventilation and the use of water.

Signs of dampness and/or mould are considered strong indicators of the risk of asthma and respiratory symptoms (such as coughing and wheezing). Ventilation and temperature adjustment, on the other hand, are important means for controlling humidity and preventing condensation. Also, ventilation plays an important role in reducing concentrations of microbial and chemical pollutants in the air.

A WHO working group on indoor air quality guidelines has made recommendations on dampness and mould in indoor spaces, but the implementation and evaluation of specific actions is difficult, due to the great variety of indoor spaces, fragmentation of responsibilities and, in the case of private residences, a limited mandate for intervention by public authorities. Therefore, while there is already a large body of evidence on the adverse effects on health of dampness and mould and the necessary measures to mitigate them, the main problem to be tackled is the implementation and application of existing knowledge. Effective and functional regulations and policies are a key requirement for implementing actions.

To discuss and review the current problems of policies and regulatory frameworks, and to conclude a set of recommendations on the priorities for policies on dampness and mould, WHO convened a number of technical experts and policy-makers from various countries to share their national experience and technical knowledge and to discuss the current challenges for providing action on dampness and mould problems in light of the existing regulatory frameworks.

This meeting represented the second expert gathering of a larger work package on “addressing policy implications of actions to reduce health risks due to indoor air pollution with biological agents” carried out by the WHO European Centre for Environment and Health (Bonn Office) and co-funded by the European Commission (DG SANCO, grant agreement 2005156). With the overall objective of formulating policy briefs on effective approaches against dampness and mould, the working group took notice of the first WHO meeting report on technical interventions and actions against dampness and mould and discussed the policy implications and requirements of health-based actions on dampness and mould.

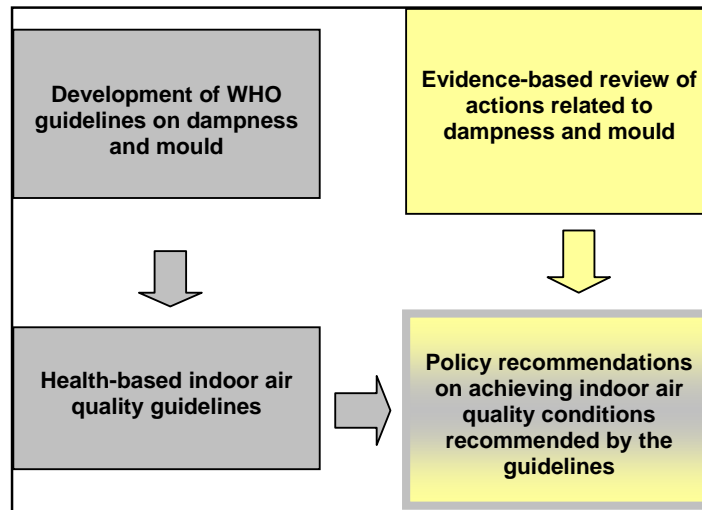
The major meeting objective, therefore, was the production of policy recommendations on effective and practical actions against dampness and mould, expressed by:

- general technical guidance and advice
- recommendations on adequate policy and/or regulatory frameworks

- advice on national and/or local implementation mechanisms
- suggestions for capacity building and/or educational approaches.

The policy advice on actions on dampness and mould problems provided by this project will also complement the WHO indoor air quality guidelines on dampness and mould (WHO Regional Office for Europe, 2009a). As the WHO indoor air quality guidelines on dampness and mould are restricted to a health risk assessment based on scientific evidence, risk management options are not addressed. Therefore, the project recommendations will also provide mechanisms and practical recommendations for implementing WHO indoor air quality guidelines on dampness and mould. Together, the advice from both projects is expected to provide strong scientific and policy-related foundations for national and international measures (Fig. 1).

Fig. 1. Science and practice: towards policy-making on dampness and mould



Review of existing recommendations on dampness and mould

To initiate the discussion on policies and technical actions against dampness and mould, a number of presentations summarize the following: the conclusions of the project's first expert meeting on technical interventions against dampness and mould; a review paper on policy and technical recommendations on dampness and mould, as proposed by other international projects and actors; and the WHO indoor air quality guidelines on dampness and mould. In addition, short summaries on national policies and interventions in the field of indoor contamination with dampness and mould were presented for 13 countries.

Conclusions and recommendations of the first WHO expert meeting on technical interventions against dampness and mould

One background document for the meeting was the report on the WHO expert meeting on interventions and actions against dampness and mould, held in February 2008 (WHO Regional Office for Europe, 2008b,c). This first expert meeting was based on a review of "good practices" derived from a variety of case studies collected by the WHO Secretariat on the prevention, mitigation and removal of dampness and mould. Three working groups identified good practice

elements based on: (a) the scientific perspective (which case studies are scientifically sound and reliable?); (b) the problem perspective (what technical action is effective?); and (c) the process perspective (which actors are in charge of what tasks?). While the meeting did conclude, based on the case studies, that only limited recommendations can be derived, there was a consensus that sufficient evidence existed for the conclusion that persistent dampness and mould in buildings may lead to adverse effects on health. Also, it was noted that the pathogenic mechanisms of dampness and mould are not yet fully understood and that it remains difficult to identify the interventions and methods that would be most effective. Still, the meeting made several recommendations on technical actions, focusing on both prevention and remediation and stressing the need to take into consideration:

- the local climate context
- the occupational behaviour, as well as the building components and/or quality
- the problem of humidity as the causal factor
- the differences between public and private settings.

The meeting participants also proposed the following:

- development of international and national guidance documents, guidance values and action tools;
- development of quality assurance mechanisms for remediation work;
- increased risk identification measures through surveys, inspections and various means of communication;
- consideration and/or clarification of the public health sector mandate for conditions in indoor environments – also in private places; and
- increased information and educational approaches for both building professionals and citizens.

The full report of the first expert meeting and the case studies discussed are available (WHO Regional Office for Europe, 2008b,c).

Review paper on dampness and mould recommendations

As a background document to the expert meeting on policy recommendations, the WHO Collaborating Centre for Housing and Health developed a summary report on policy recommendations on dampness and mould proposed by recent international projects or reports (see Annex 1). The report summarizes a number of WHO or European projects and reports and identifies their main recommendations on dampness and mould.

The report concludes that there is much evidence on effective solutions, such as solving the causes of moisture problems, removing mould and damaged materials, and improving ventilation and thermal insulation. Also, much is known about measures to prevent mould and moisture, both in relation to construction features and occupant behaviour.

However, the review shows that there are still gaps in knowledge about: the cost–benefit assessments of dampness and mould mitigation; the effectiveness of penalties and incentives to landlords and housing managers; the degree of education experts need for mould prevention and remediation; and the effect of information programmes for the public.

Based on this technical assessment, the strongest and/or repeated recommendations made by the individual projects are:

- the need for guidance values, regulations and norms (possibly for different indoor settings);
- improved quality of buildings through design guidelines and other means;
- improved education of building professionals;
- public information and awareness campaigns;
- an adequate balance between heating, ventilation and moisture production;
- the development of *building manuals*; and
- regular inspection and maintenance of building energy and ventilation systems, as well as improved risk identification and/or monitoring measures for indoor environments.

Annex 1 contains the review paper on policy recommendations.

WHO indoor air quality guidelines on dampness and mould

The report *Development of WHO indoor air quality guidelines: dampness and mould* (WHO Regional Office for Europe, 2008d) served as an additional background document for the meeting and provided the context for the development of recommendations on dampness and mould interventions. This was considered especially relevant, as the guidelines focus on qualitative guidance and recommendations on the recommended indoor environment conditions, but do not address mechanisms for achieving those conditions. The recommendations of the guidelines – recommending that indoor environments be free (as much as possible) from dampness and mould and that immediate action be taken if such conditions tend to occur over longer periods of time – therefore provide the objectives for any policy and technical recommendations on dampness and mould. The meeting report (WHO Regional Office for Europe, 2008d) is available.

Country reviews of selected dampness and mould actions

To review existing policies, regulations and approaches to the prevention, identification and remediation of dampness and mould in indoor settings, one participant for each country represented at the meeting was asked to shortly summarize the national situation for three specific regulations or systematic approaches.

1. How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?
2. Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?
3. What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould? What could be most effective?

Annex 2 contains the national summaries prepared by participants from various countries.

Application and health benefits of policies on dampness and mould

After the discussion of background documents on policy recommendations, a set of presentations facilitated the theoretical and practical benefits of applying improved or innovative policies to respond to indoor environments contaminated by dampness and mould.

EnVIE project

The EnVIE project (de Oliveira Fernandes et al., 2009), co-funded by the European Union (EU), had just been completed and came up with an assessment of the potential public health benefits of improved policies on indoor environments.

- The main health threats in the indoor environment were identified to be tobacco smoke, combustion products and bioaerosols.
- The highest public health benefits at the lowest cost and smallest delay can be achieved by restrictions on smoking.
- High long-term benefits at a high cost can be achieved by building and ventilation policies that control indoor exposure to particulate matter, allergens, ozone, radon and noise from outdoor and indoor sources.
- Substantial medium-term benefits can be expected at a medium cost from policies that ensure better building documentation, management, inspection, task assignment and training of responsible individuals.
- Substantial medium- to long-term benefits at costs ranging from low to high can also be expected from policies aimed at:
 - preventing moisture accumulation and, thus, mould growth in buildings and
 - preventing exposure to exhausts of indoor combustion sources.
- Substantial short- to medium-term benefits at a low cost can be expected from harmonized testing and labelling of indoor materials and consumer products.

The specific assessment of preventing dampness and mould by applying appropriate guidelines for building construction and maintenance was estimated to be at 26 000 disability-adjusted life years per year (for the EU) if only in 10% of the buildings the risk of exposure could be reduced through adequate construction. Following up on the research-related EnVIE project, three practical examples of implementation on different governmental scales – national, regional and local – were presented and discussed.

Indoor environment survey in Luxembourg

Supported by the Ministry of Health, a service was initiated in the early 2000s that provides the opportunity for residents to have their indoor environment checked and measured when a doctor's diagnosis indicates potential exposure sources within the home environment. The service covers a wide range of environmental pollutants: chemical, physical and mycological. Although the majority of dwelling inspections were related to chemical pollutants, dampness and mould played a role in more than 10% of all dwellings visited.

Laboratory analyses – financially supported by the Ministry of Health – give detailed feedback to residents about their personal exposure and have proven effective in:

- helping occupants to solve their mould problems

- increasing the success rate of medical treatments
- facilitating action by landlords and building owners
- setting priorities for preventive measures.

The Green Ambulance in Brussels

A rather similar system focuses on the support of medical and environmental diagnoses and aims to provide solutions. It was developed by the Brussels Institute for Management of the Environment, which collects data to further evaluate indoor pollution priorities and set prevention strategies. In the Brussels cases, dampness and mould are among the main problems identified.

Based on collaboration between analysts from the Brussels Institute for Management of the Environment, mould experts from the Belgium Scientific Institute of Public Health and nurses from a nongovernmental organization that specializes in community health, requests for inspections filed by medical doctors are followed by visits to dwellings and measurements of key indoor parameters. The results are sent to the physician in charge and are provided to the patient, along with adequate advice on steps to take to remove potential risk factors. After implementation in about 1000 inspections of dwellings, the success rate (as perceived by the patients) is at 70% (perceived health improvement one year after the intervention), while the doctors involved identified health improvement in 58% of all cases.

Consulting and mediation services in Bielefeld

The interdisciplinary consulting and mediation service on dampness and mould problems in rented homes is a pilot project initiated by the consumer protection agency of the state North Rhine Westphalia that is implemented in the city of Bielefeld. It has been developed to respond to an increasing demand by tenants for support in technical, legal and health issues in relation to dampness and mould. Main conflicts between tenants and owners regarding causes of and responsibilities for excessive dampness are most often due to an unclear situation with exposure and/or removal. The service for tenants and owners in case of such conflicts includes an interdisciplinary on-site inspection in the home to find the respective causes and to provide recommendations for adequate remediation. General solution suggestions for the dispute between owner and tenant are negotiated in the respective home (using a small „round table“-discussion). The approach taken is pragmatic as it tries to apply as little input as possible, although some quality standards are to be considered. The main objective is to get a quick and acceptable solution for both sides and avoid useless lawsuits. During the pilot phase, good experiences were made as in most cases the causes of the respective problems could be identified, adequate solutions were found, exposure times reduced, correct removal activities initiated and – in consequence - court cases avoided.

Working group sessions: conclusions and recommendations

To discuss the available policies, regulations and practices on dampness and mould, the meeting participants were divided into three working groups that addressed specific subjects. Taking into consideration the results of the recent expert meeting on practical interventions against dampness and mould and the background documents provided, the working groups were charged with selecting a list of recommendations on dampness and mould that would relate to policies, regulations and general approaches taken by policy-makers and responsible agencies. To cover the legislative and executive dimension, one working group addressed the legislative dimension (recommendations on (inter)national regulatory frameworks), while another group was asked to focus on the executive dimension, investigating mechanisms for implementing action on dampness and mould at the local level. The third working group was to discuss providing the public with information and identifying suitable mechanisms to provide guidance, support and information to private households or other population groups affected by problems with dampness and mould.

Working Group 1: (inter)national regulatory frameworks

The Chairperson of working group 1 was David Ormandy, and its members included Maria José Carroquino Saltó, Michael Davies, Corinne Drougard, Christian Farrar-Hockley, Matti Jantunen, Anne Pia Koch, Laura Kolb, Jarek Kurnitski, Katarina Slotova, Greta Smedje, Piet van Luijk, Claudia Weigert and Ingrida Zurlyté. The working group started with the common acknowledgement that there is no internationally accepted definition of dampness and/or mould (identifying the quantity of dampness and mould that could or should be considered a threat to health), which makes it difficult to develop targeted and effective regulations. In addition, the discussion of adequate legal frameworks is also affected by the different legal and administrative structures and environments in each country in the WHO European Region.

The discussion in working group 1 was guided by four questions, for which the group was asked to develop a consensus statement for each. These statements provide a first overview of the current situation and also potential ways to proceed. The four questions and their respective consensus statements follow.

Are existing regulatory frameworks adequate? If not, why not?

On the premise that a *regulatory framework* provides the means to apply related standards and/or regulations, the group noted that for new buildings (yet to be constructed) a regulatory framework does exist in most (if not all) countries. Regarding the existing building stock, the group noted that such a regulatory framework exists in some (but not necessarily all) countries. Although the “why not” part of the latter question was not investigated in detail, it seems safe to assume that the standards and regulations applied to existing buildings are often not on the same level as those applied to new building stock.

What elements and regulations, for example, would be necessary or desirable? What should be their key objectives?

For *new buildings* (yet to be constructed), the group agreed on the following two basic objectives.

1. Performance standards are the desirable format for regulations, as they assure that a defined condition or outcome is achieved – for example, the proposed indoor temperature range to

be achieved. In industry and/or commerce, however, specific standards are often preferred, as they are easier to fulfil and to document – for example, when heating systems and insulation matching pre-given characteristics are installed.

2. Standards should focus on health and, therefore, involve ministries of health, as they are the guardians of public health. In many instances, however, ministries of health do not have the appropriate experience and expertise.

For *existing buildings*, the group agreed on the following three basic objectives.

1. Performance standards related to quality and outcomes are again preferable to specific standards related to equipment.
2. Standards should focus on health and be developed with input from the ministries of health – examples are available from, for example, Sweden and the United Kingdom.
3. Although the same principles of quality should apply, it may prove impractical for existing buildings to reach the same target or performance as that for new buildings. In such cases, the main objective should be to remove the key threats to health and ensure safe and healthy indoor environments, to the extent possible.

The working group agreed that it is insufficient to have a framework and relevant regulations. There also need to be adequate mechanisms for enforcement and quality control.

Next to regulatory approaches, alternatives are, for example, voluntary agreements (where everyone *buys-in*) and financial arrangements (where insurance premiums are lowered when expert guidance is followed).

What is the expected role of international and national actors?

The group identified the following actors on both the international and national levels:

- International: EU, WHO, professional organizations, resident, owner and consumer associations, among others.
- National: governments (ministries in particular), professional organizations, the building and construction sector, the health sector, resident, owner and consumer associations, and all who may visit homes in a professional capacity (such as emergency services, surveyors and construction and/or maintenance professionals, and such health system visitors as midwives).

The group identified a range of relevant tasks for the following actors and stakeholders that could improve the situation.

- The EU could provide directives that require (performance) standards to be adopted and adapted to local or national circumstances (considering whether there are already European standards, such as those provided by the International Organization for Standardization).
- WHO could provide guidelines and guidance on policies and regulations based on health evidence.
- Professional organizations (international and national) could provide expert guidance, including how to apply that guidance.
- Building sector experts could talk with the health sector, to reach a common understanding

(and vice versa).

- Health agencies could install so-called one-stop-shop opportunities for providing advice to consumers.
- Housing and health actors could develop and support campaigns for owners or residents to promote awareness on health issues that relate to housing.
- Those professionals who visit homes could be made aware of potential problems and possibilities for providing advice and solutions, among other things.

Who will be the main stakeholders and/or responsible institutions for establishing, implementing and enforcing such regulations?

Internationally, the main stakeholders and responsible institutions will be the EU, through DG Enterprise, DG SANCO and DG Environment. Nationally, the main stakeholders and responsible institutions for establishing regulations will be national governments, through health and housing ministries. The implementation and/or enforcement will then depend on the legal and/or administrative framework.

The working group raised additional sensitive points that need to be considered for the development and implementation of any regulation or legal guidance. One point that often proves to be problematic in legal terms is the lack of clarity about the main responsibilities for housing and building quality, which in the case of rented properties can be with the owner or landlord or with the renting party or occupier. For problems of dampness and mould growth, in particular, court cases are often concerned with attributing the cause of the problem to the state of the building or occupant behaviour and to apportioning blame.

If a standard, regulation or guidance tool is provided by responsible authorities, the working group recommends to keep in mind that:

- there should be measurable or quantifiable outcomes and results associated with it, so performance can be evaluated – either directly in terms of health or indirectly in terms of exposure levels);
- these should address equity issues to provide adequate services to all people and population groups affected.

Recommendations

Acknowledging that dampness and mould growth are threats to health in their own right, the group agreed on the following recommendations.

- Dampness and mould should not be seen in isolation, but should be seen as one of the many potential threats to health in buildings.
- Dampness and mould should therefore not be the sole focus of any regulation and should rather be integrated into more holistic regulations that target building quality in their overall performance.
- Regulations on dampness and mould need to be associated with regulations on thermal comfort and heating devices, insulation, ventilation and air exchange.

Regarding the recent experiences with EU directives on construction materials and building performance, the working group suggested that any directive on building construction and on the maintenance and condition of existing buildings that may threaten health and/or safety should take account of and/or include the following:

- require countries to adopt and implement regulations to require remedial action to deal with existing buildings (dwellings and buildings where the public has access) that are a threat to health to the users as a result of the presence of dampness and/or mould growth (as well as other threats to health); and
- require countries to adopt and implement regulations to ensure that new buildings and buildings being renovated (dwellings and buildings where the public has access) are so designed and constructed as to ensure that there is no threat to health to the users as a result of the presence of dampness and/or mould growth (as well as other threats to health).

On a national scale, the working group recommended that governments initiate or maintain and further develop activities aimed at protecting the public from building-related environmental risk factors. For successful action, it was considered to be especially important to:

- adopt regulations and/or legislation to place on the appropriate enforcement agency duties to identify buildings that are a threat to the health of users, including threats from the presence of dampness and/or mould, and duties to require appropriate remedial action to remove the threats; and
- ensure that existing regulations and legislation address threats to health from the presence of dampness and/or mould.

With respect to the lack of clear criteria on the presence of dampness and mould and its relevance to health, the group suggested that every country:

- provide a definition of the relevant criteria for assessing dampness and/or mould, to determine whether there is a threat to health of users; and
- adopt health-based indicators, to ensure that the activity focuses on remediating buildings where there are threats to health, including threats from dampness and/or mould, and to ensure that remediation work results in health benefits.

Looking at the varying degrees of sensitivity to such problems as dampness and mould, the working group also developed the following recommendation on assuring equity in governmental activities.

- It would help greatly if governments ensured that dampness and/or mould remediation programmes adequately address the needs of children (including schools), the elderly (including nursing homes), those otherwise considered deprived or infirmed (for example, immunocompromised individuals) and, in particular, the public and social housing stock.
- Remediation programmes should – to the extent possible – exclude the application of biocides in mould treatment and removal.

Going beyond the directly responsible authorities on housing, construction and health, the working group discussed the responsibilities and/or opportunities of insurance companies to become involved in preventive actions, to avoid or reduce problems due to dampness and mould in indoor settings, and came up with the following recommendation.

The insurance industry should be required to include consideration of the potential for buildings to suffer from problems of dampness and/or mould when determining premiums and coverage.

As the United Nations agency with the mandate for public health protection, the working group recommended that WHO could support Member States by:

- preparing guidelines and guidance on defining housing-related threats to health, including threats from the presence of dampness and/or mould in buildings; and
- preparing guidance on the assessment of the potential adverse effect on health of inadequate housing.

Working Group 2: local implementation mechanisms

The Chairperson of working group 2 was Catherine Bouland, and its members included Ralph Baden, François Belanger, Nathalie Duclouvel-Pame, David Kelly, Bernhard Link and Lars Molhave.

The discussion in working group 2 focused on the implementation of the given regulatory framework, which in most countries is the mandate of local authorities. Again, the discussion was guided by four questions for the group to address before developing a set of recommendations.

What are the main challenges and problems for local action?

At the sub-national level – municipal or regional – a wide range of challenges and restrictions to implementing protection and remediation measures was identified. Clearly, the overall challenges will be different in any given municipality for the following reasons.

- Funding and resources (especially trained staff) to adequately identify problem buildings and respond to the identified needs may be lacking.
- Citizens, renters and owners may lack awareness of the problem and knowledge about its adverse effects on health.
- Without a particular department clearly leading the effort, a split of responsibilities within a municipality may result in slow technical progress and increased administrative burden – for example, housing, health, environment and social departments could be more or less involved.
- Information and complaints on building-related problems go to various actors inside local authorities (such as housing, health or social departments) and outside (such as housing owners, doctors, nongovernmental organizations or consumer protection agencies) and are difficult to consolidate, as they usually are not exchanged.
- National regulations and policies may be vaguely defined and need to be translated to the local (or sub-national) conditions.

- There may be little effect on (and mandate for) the existing housing stock unless problems become severe. Also, mandates may be highly insufficient or there may be a lack of enforcement of existing mandates in national regulations on indoor air quality in private dwellings.
- There may be a challenge to integrate issues on dampness and mould into dominant societal trends and regulations on energy efficiency.
- Local authorities may have potential conflicts of interest when they have to apply regulations to their own buildings and public housing stock and when they have to provide new dwellings.
- An operational definition of dampness and mould may be lacking.

What solutions are available? How can local action to prevent, reduce and/or mitigate dampness and mould be supported? What mandate is needed by local authorities to do so?

It would be extremely helpful if supralocal authorities (such as international, national and regional authorities) gave a clear mandate to local authorities to adapt national (and implement local) actions on dampness and mould. The potential content of such a mandate would be to:

- define a unique *institutional body* in charge of actions on poor indoor conditions, including dampness and mould (internal coordination);
- identify, clarify and define responsibilities for (and coordinate activities of) different actors and stakeholders, including networks;
- initiate the provision of information and communication and dialogues with stakeholders, including construction workers and citizens; and
- establish and administer local action plans.

Also, the international public health community should provide an operational definition of dampness and mould that local authorities can apply to risk assessment and risk management. Moreover, local authorities should have adequate resources (such as funds, staff and information) to respond to environmental and health challenges within the built environment and, especially, within public-owned buildings or those used for public needs.

Best practice awards should be established by providing a *certificate of healthy building* after construction or renovation. This certificate could be established following a total assessment of the building, including, for example, dampness and mould, energy performance and ventilation.

Finally, health objectives should be integrated through various regulatory tools – for example, building codes and urban planning laws.

On a local level, what priorities exist and how should different settings be tackled?

To target specific settings on a local level (such as schools and day-care centres versus private homes) and vulnerable population groups, it is necessary to combine actions. In relation to building types, local authorities – through their mandate – need to focus on public buildings. First priority action is necessary for buildings in which the public receives long exposure times (such as hospitals, day-care institutions and schools). Second priority should be given to buildings that receive the public with short exposure times (such as public offices and libraries).

Only then can private residences be considered – unless specific mandates are given to local authorities to also address conditions in private dwellings.

Who would be the main stakeholders and/or responsible institutions for establishing, implementing and enforcing local action?

Local authorities with the participation of all other stakeholders (such as nongovernmental organizations, consumer protection agencies, housing agencies and/or tenant groups and building professionals) would collaborate in a transparent manner. Also, within the local authority, a lead department has to be identified.

In addition to these positions developed by the working group, three additional questions were identified that need to be answered by the local authority to provide adequate directions and capacities for dealing with the problems of dampness and mould in buildings. These additional questions are as follows.

1. To what extent do local authorities have the authority to enter a private dwelling and remove occupants or request remediation measures when dampness or mould has been detected?
2. Should priorities really be set according to the mandate of local authorities (which are mostly related to public-use buildings), which then may be in conflict with priority health needs (considering that many problems may exist in specific vulnerable population groups and within private-use buildings and dwellings that would not be covered by a focus on public-use buildings)?
3. How should action plans that adequately address both new and existing buildings be developed?

Recommendations

Acknowledging that several relevant regulations are already available to support local implementation mechanisms, the working group agreed upon the following.

Local authorities (should) have the mandate and responsibility to act on dampness and mould. For adequate implementation, a *local body* should be identified and/or established as being responsible for acting on dampness and mould (and indoor and/or built environment problems in general).

To provide structure and consistency to the municipal approaches to help deal with problems, the working group recommended the following.

- Actions should be coordinated through a defined action plan, to ensure a consistent approach. Therefore, local authorities should establish and/or develop an action plan inspired by practical action and that lends support to affected citizens and includes clear definitions of the monitoring, evaluation and revision mechanisms to be applied. The action plan should be used in all cases (apart from exceptional circumstances) and should foresee the need for adequate resources.
- Support (such as financing, manpower, information, tools, and regulations) from an upper level should be given to develop and implement the action plan.

As dampness and mould problems in the built environment touch upon the responsibilities of a number of municipal departments, responsibility for leadership and/or mandates within the action plan need to be clarified. To clarify these issues, the working group recommended the following.

- A locally appointed *body* should enforce and/or implement a mechanism for dealing with dampness and mould.
- This local body should enforce mechanisms to:
 - inform and support occupants, thus ensuring equity;
 - facilitate interactions and/or dialogues between all stakeholders;
 - encourage a holistic approach towards housing defects (inform, coordinate and collate information), with emphasis given to the involvement of the health sector in a multidisciplinary approach;
 - encourage the cooperation of different sectors;
 - encourage the integration of community associations (including the evaluation and follow-up of the action plan); and
 - guarantee respect of building codes.

Finally, local experiences need to be tracked and put together on higher levels to provide better overviews on regional or national *problem patterns*, and the following is recommended.

Local authorities should report to the next level up and share their experiences.

Working Group 3: public perspective – guidance, support and information

The Chairperson of working group 3 was Evert Hasselaar, and its members included Iris Kompauer, Marle Kopf, Rémi Poirier, Nathalie Röbbel, Diana Smith and Regine Szewzyk. The discussion in working group 3 focused on the public perspective of actions on dampness and mould and dealt with the identification of appropriate mechanisms to provide information and support services to the public or specific groups of society. Again, the discussion was guided by four questions for the group to address before developing a set of recommendations.

What are the main areas and target groups for education, information, capacity building and related activities?

The working group adopted a broad view of the needs and target groups for the provision of information on dampness and mould. Besides the general public – as a basic target group for health promotion and health education – the experts identified the following target groups:

- sub-populations with specific vulnerabilities, such as:
 - immunocompromised people
 - migrants
 - low-income groups and groups with low socioeconomic status
 - children and/or infants (and their parents)
- medical service providers (such as general practitioners, physicians and nurses)
- craftsmen and construction workers

- housing associations
- facility managers
- building inspectors (such as those for energy certificate inspections)
- architects
- lawyers
- teachers, their students and education system staff in general.

What information format, content and way of selling it would be relevant for each target group?

The expert group suggested that there should be general information for the public, as well as specific information for individual target groups (see above). The major means of communication identified were:

- written material: brochures, leaflets, pictures of technical details
- web sites
- videos (such as do-it-yourself videos) and DVDs
- TV coverage based on local news items.

It was considered to be of major importance that communication about the risks involved was done in careful ways, to avoid shocking or terrifying the target groups, and that the information provided focused on applied and practical (instead of theoretical or scientific) information.

Mechanisms to address the public or selected specific target groups were considered, as follows.

- The national health authorities should organize a long-term dampness and mould awareness campaign to support the transfer of information to actors on all levels.
- Networks should be established or existing networks used to produce and/or disseminate information on dampness and mould.
- The responsible health authorities should take the lead to set up a national level group that includes policy experts, technical experts, user representatives and communication experts, to create an action plan that should include adaption, dissemination and promotion of appropriate materials for the different stakeholders.
- Parent groups and their networks should be used for information transfer that relates to the protection of children.
- Special action should be undertaken for migrants, low-income households and residents of social housing, as well as for residents with specific health conditions.

How should non-experts be enabled to make correct decisions and how should they be enabled to get needed exact and scientifically sound support?

The group summarized the following key sources of information to enable consumers to make adequate decisions:

- information available through media (as listed above);
- local nongovernmental organizations, agencies or institutions offering support and advice on dampness and mould;
- dedicated officials at the municipalities (health and/or housing departments);

- information networks for landlords and renting institutions on the benefit of preventing and remedying mould problems; and
- adequate information to medical and housing-related advisors (such as landlords, housing agency staff and medical doctors).

Who would be the main stakeholders and/or responsible institutions for establishing, implementing and enforcing such action on information and education?

The working group agreed that success can only be achieved with the full collaboration of health and housing sector professionals, and they supported the development of *Health In All Policies* approaches to integrate health concerns into housing and environmental strategies. In essence, the group identified the following potential actors at the international, national and local levels.

- At the *international level*, the group identified: WHO; international umbrella organizations of housing agencies, health agencies and medical associations, nongovernmental organizations and consumer protection agencies; and the European Commission.
- At the *national level*, the group identified: national governments and ministries; sector representatives for housing, health, environment and construction; national-level nongovernmental organizations and interest groups, patient groups and tenant associations.
- At the *local level*, the group identified: health and housing authorities; local offices of nongovernmental organizations and consumer protection agencies; and medical service providers, such as doctors, caregivers, occupational therapists or midwives.

Possibly the *most effective* facilitators of information about dampness and mould are: social housing associations, medical service providers and health interest groups.

Recommendations

Working group 3 agreed that the main purpose of the information provided was to prevent the problem of excessive dampness and mould. They also agreed that information on how to handle and remove mould was needed. Information to the public should thus focus on four main messages:

1. **moisture production:** addressing different household situations and activities, and including tips on how to reduce and/or control humidity levels;
2. **health effects:** the potential adverse consequences of dampness and mould;
3. **ways to remediate:** different levels of exposure during remediation and potential health effects, do-it-yourself measures or professional contractors, adequate do-it-yourself measures; and
4. **external support options:** who can support guidance and/or information (translated for local circumstances).

If available, information on public support, including costs for inspection and remediation, should also be included.

To enable the adequate detection and prioritized removal of mould problems, the group recommended that a number of steps be undertaken for: the general public, low-income groups and those in poverty, and vulnerable residents with specific health conditions; and the housing and health sectors, and policy-makers and governmental actors.

For the *general public*, the group recommended the following steps:

- develop and widely disseminate information – for example, through WHO, public authorities and other dissemination networks, such as nongovernmental organizations and consumer agencies;
- consider children as both a group at risk of exposure and a tool to disseminate information to parents and households – for example, through education at school and specific attention from physicians and nurses; and
- include mould in performance assessments and inspections of housing quality undertaken in relation to other processes, such as energy certificate inspections, which would require a modification of legal status to use visits from professional inspectors to dwellings.

For *low-income groups and those in poverty*, the group recommended the following steps:

- focus on low-income groups and migrants, the groups known to have the worst housing conditions and the groups that may have the least capacity to maintain tight building surfaces and to heat the dwelling as required, thus leading to a potential area for action for social support and action from housing authorities; and
- targeted action that includes information about awareness and prevention of mould, as well as having support services that deal with mould problems.

For *vulnerable population groups with specific health conditions*, the group recommended the following steps:

- provide specific information tools and networks for immunocompromised people – for example, guidelines and recommendations written for patients and available to doctors); and
- inform residents with respiratory problems and make available specific information for general practitioners, nurses and specialists on respiratory diseases – potential actors: WHO, insurance companies or national health agencies, as well as asthma and/or allergy organizations.

For the *housing and health sectors*, the group recommended the following steps:

- increase awareness among medical professionals and doctors of health outcomes typically associated with mould exposures, through continued education on environmental triggers of disease and modified university curricula;
- provide general health examinations that include the home environment as a crucial health setting;
- create financial incentives to support preventive actions – for example, by insurance companies;
- support the medical profession to take appropriate curative and preventive action, by establishing appropriate collaborative housing and/or environment monitoring systems;

- train and educate craftsmen and building professionals, through harmonized national education and mould detection, and remediation certification schemes;
- have building professionals and inspectors recognize dampness and mould as a quality indicator in performance assessments;
- develop standards and regulations for the quality performance of buildings – including the prevention of dampness and/or mould – for the construction sector and convey knowledge of them to the public; and
- develop user manuals for every building – including recommendation for the owner and the occupants on how to deal with the specific characteristics of the building, such as how to prevent dampness and mould.

For *policy-makers and governmental actors*, the group recommended the following steps:

- promote public awareness of the adverse effects of dampness and mould on health;
- integrate dampness and mould issues into medical services, medical and school education, building performance assessment, and energy saving strategies;
- promote quality among building inspectors, construction workers and craftsmen; and
- set requirements for certification of mould-remediation workers.

Meeting conclusions

From the final discussions and comments of the working groups, and based on their prior recommendations, the following conclusions were derived as main recommendations by the expert group.

Legal and regulatory context

In legal terms, much of the responsibility for preventing dampness and mould belongs currently to the residents and users of buildings. For them, it is often difficult to identify the occurrence of potential problems, their causes, and the appropriate measures to deal with them. Also, building residents and users are expected to adapt their behaviour to compensate for deficiencies in the building, such as low energy efficiency (insulation and provision for heating) and inadequate provision of ventilation.

The legal settings provided by most countries to deal with dampness and mould problems tend to be vague, requiring expert knowledge to select and implement the correct actions and interventions. More specific regulations, providing performance-based standards to be kept and maintained by the responsible housing actors, need to be developed to better control the housing conditions and quickly identify inadequate conditions that need to be tackled.

Although the application of voluntary agreements between housing owners and residents is often helpful, legislation remains a major tool in the field of dampness and mould prevention, as in most cases there is a debate on the responsibility and causal factor for the development of dampness and mould problems. Clear regulations and legislative tools, based as much as possible on defined health-based end-points, therefore help to describe the responsibility of the occupants and also help residents to put pressure on building owners or housing agencies in case of no remediative action. Policy approaches to preventing dampness and mould should therefore consider both the extent of soft policies – such as voluntary agreements and/or targets between the housing actors – and the hard policies of legal frameworks. In problem cases, priority should be put on mediation and problem solving, to avoid court cases and provide quick and pragmatic solutions that benefit both sides.

In the framework of Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (European Parliament, Council of the European Union, 2003), there is considerable concern about the dominance of the energy saving arguments in relation to the requirements for sufficient air exchange and the quality of indoor air in general terms. National application of the Directive, and especially the energy certificates, should give more consideration to the general requirements for an adequate indoor climate and the balance between energy and ventilation needs.

Local authorities and their mandate

Local authorities should – if not yet available – be equipped with a clear mandate (including budget and/or resources) to work on the problem of dampness and mouldy buildings, as they are the level of public authority closest to the people. Due to their mandate, local authorities are often forced to focus on and prioritize work for public buildings, such as schools, day-care settings (for example, nursing homes and day-care centres) and administrative buildings and offices. For many local authorities, however, the mandate also includes the (sometimes quite large) public housing sector.

Local authorities should also find suitable ways to provide a minimum set of services for households living in private housing stock. These services should focus on information and advice on preventing dampness and mould and on support for problem cases (such as no remediative action by the building owner or severe cases of exposure) and should also provide the capacity for making measurements and performing laboratory tests.

In addition, local authorities can include the prevention of dampness and mould in the work mandate of their departments of health, environment, social services and housing. They can also develop a local strategy for action on dampness and mould. This strategy should identify the legal basis for empowering medical specialists and/or housing inspectors to act (also in private housing stock) if clearly inadequate conditions are found or medical diagnoses strongly suggest the presence of indoor environment-related risk factors. Another potential strategy component could be regular control of specifically selected building conditions.

Provision of information and support mechanisms

With regard to the provision of information on dampness and mould, there is a need to identify the different stakeholders in need of information and support and to provide them with such help in rather different ways and different levels of expertise. There is also a need to identify possible groups and networks that can help disseminate the information to the different target groups. The major target group in need of information and support includes building residents and occupants (in schools, these would be teachers and students) who need to be informed about the problem and the symptoms that accompany it.⁵

Besides the public, specific target groups include: building owners and caretakers; construction experts and/or companies and building-related professions (possibly being extended, for example, to policy-makers in the field of building codes); and medical professionals, such as doctors and nurses (especially in relation to vulnerable population groups with specific medical conditions).

Specific information needs to be developed and disseminated to vulnerable population groups – such as people with asthma, allergies or respiratory disorders; immunocompromised people; and children and the elderly. Other target groups may be identified through approaches that focus on housing quality, thus targeting mostly poor households and migrant groups.

The information given to the public or specific groups should provide advice on preventing dampness and excessive moisture (for example, through information on adequate residential behaviour, ventilation and building maintenance) and on suitable steps to be taken if mould growth does occur.

As building users are not specialists trained in building inspection, it is most relevant for them to be aware and informed of the key indicators and so-called telltale signs that indicate problems with moisture or mould (or building problems in general). Awareness of such problems would

⁵ As one deliverable of the project on “addressing policy implications of actions to reduce health risks due to indoor air pollution with biological agents”, the WHO Regional Office for Europe and the Health and Environment Alliance (HEAL) will produce a public information brochure on preventing and removing dampness and mould problems. In addition, HEAL was subcontracted to compile a list of national agencies and institutions that provide free information and advice to the public on dampness and mould problems. The brochure (WHO Regional Office for Europe, 2009b) and the list of information sources (HEAL, 2009) are available at http://www.euro.who.int/Housing/support/20080403_1

then enable building residents and occupants to actively search for information and advice on how to best handle the situation. For this, targeted and easy-to-access information needs to be provided by health, housing and consumer protection agencies, which tend to be the first agencies contacted for support.

The development of housing manuals that summarize the operative tasks and challenges of the building, its construction style and its equipment is generally supported, but its value is restricted to those areas of daily life that can be affected by residents. Building manuals can not replace the need for adequate building construction and regular building maintenance by professionals, and especially the identification of potentially invisible or hidden problems (for example, within the building structure). Such manuals, however, can be effective as a guidance and information tool to the building users and therefore represent a viable tool for preventing problems.

Professional sectors

For the medical professions, a lack of awareness of environmental triggers of disease was noted as a major challenge to be tackled. To avoid that after diagnosis of allergic or respiratory diseases, patients are sent back to their home which may be the source of the problem, medical experts should be made aware of key indicators and typical health outcomes associated with indoor environments. Appropriate mechanisms for including the home (or school or office) environment in medical diagnosis and therapy choices should be developed and supported.

The housing and construction sector needs to consider modification of training and education curricula, to increasingly address the relevance of building quality and its links to health. Performance-based standards, clear construction criteria and guidance or guidelines on maximum risk factor concentrations should be considered, applied, and evaluated and/or monitored during and after construction. Certification schemes for construction, for building rehabilitation and, especially, for mould remediation have to be developed and implemented. To this end, the larger housing agencies and umbrella organizations should develop – in close collaboration with the health community – guidance for their members.

Preventive approaches

The working groups agreed unanimously that the key approach – in terms of policy and technical aspects – should be to avoid and prevent, and if necessary reduce and minimize, the problems of excessive dampness, condensation and mould growth. Besides providing adequate training and education – for example, for occupants, owners and construction and/or maintenance staff – monitoring systems to identify such housing inadequacies as dampness and mould could be installed.

In the specific area of mould prevention and remediation, the working groups recommended that policy-makers, information agencies and housing experts be very cautious about the application of (or the suggestion and/or recommendation to apply) biocides and chemical agents. As a simple rule, the meeting conclusion on this sensitive point was to fully avoid the use of biocides and/or chemical compounds for the prevention of mould and, to the extent possible, to minimize their use in mould remediation work.

A call for holistic approaches to healthy built environments

Irrespective of the level of regulation and enforcement, it is recommended that dampness and mould issues be dealt with in the context of healthy buildings and be considered as one potential problem in many. Policies intended to affect dampness and mould – or biological contamination

in general – should therefore be embedded in more general strategies and campaigns on healthy housing, healthy schools, or healthy buildings in general. Policies that tackle only one dimension of inadequate built environments, while failing to address other dimensions, will neither be able to achieve increased health nor be able to produce social and residential stability in deprived neighbourhoods.

References

Antova T et al. (2008). Exposure to indoor mould and children's respiratory health in the PATY study. *Journal of Epidemiology and Community Health*, 62(8):708–714.

Baden-Württemberg Regierungspräsidium Stuttgart Landesgesundheitsamt (2001). *Netzwerk Schimmelpilzberatung Baden-Württemberg*. Stuttgart, Regierungspräsidium Stuttgart Landesgesundheitsamt (http://www.schimmelsanierer.com/upload/dl/Informationsmaterial/Faltblatt_180907.pdf), accessed 20 May 2009).

Carrer P, Rameckers E, Kotzias D (2003). *Policies and actions concerning indoor air pollution in dwellings in Europe and overseas*. (http://www.efanet.org/activities/documents/6Full-length-report_P_Carrer.pdf), accessed 15 May 2009).

Dacquisto DJ, Crandell JH, Lyons J (2004). *Building moisture and durability: past, present and future work*. Washington, DC, Partnership for Advancing Technology in Housing (<http://www.huduser.org/Publications/pdf/BuildingMoistureandDurability.pdf>), accessed 15 May 2009).

de Oliveira Fernandes E, Leal V, Craveiro F (2007). On strategies to prevent condensation in buildings. In: de Oliveira Fernandes E et al., eds. *First EnVIE Conference on Indoor Air Quality and Health for EU Policy, Helsinki, Finland, 12–13 June 2007*. Porto, EnVIE (http://paginas.fe.up.pt/~envie/documents/EnVIE_conf_proceedings_30-08-2007.pdf), accessed 15 May 2009):109–118.

de Oliveira Fernandes E et al., eds. (2007). *First EnVIE Conference on Indoor Air Quality and Health for EU Policy, Helsinki, Finland, 12–13 June 2007*. Porto, EnVIE (http://paginas.fe.up.pt/~envie/documents/EnVIE_conf_proceedings_30-08-2007.pdf), accessed 15 May 2009).

de Oliveira Fernandes F et al. (2009). *Co-ordination action on indoor air quality and health effects. Publishable final activity report*. Porto, EnVIE (<http://paginas.fe.up.pt/~envie/documents/finalreports/Final%20Reports%20Publishable/Publishable%20final%20activity%20report.pdf>), accessed 15 May 2009).

ENHIS (2008). *Children living in homes with problems of dampness*. European Environment and Health Information System (http://www.enhis.org/object_document/o4720n27384.html), accessed 20 May 2009).

EPA (2001). *Mold remediation in schools and commercial buildings*. Washington, DC, United States Environmental Protection Agency (http://www.epa.gov/mold/mold_remediation.html), accessed 15 May 2009).

EPA (no year given). *A brief guide to mold, moisture, and your home*. Washington, DC, United States Environmental Protection Agency (document EPA 402-K-02-003; <http://www.epa.gov/mold/pdfs/moldguide.pdf>), accessed 15 May 2009).

EPA (no year given). Mold Web Course [web document]. Washington, DC, United States Environmental Protection Agency (<http://www.epa.gov/mold/moldcourse/moldcourse.pdf>, accessed 19 May 2009).

EPA (2009). IAQ Tools for Schools Program [web document]. Washington, DC, United States Environmental Protection Agency (<http://www.epa.gov/iaq/schools/>, accessed 19 May 2009).

European Commission (2002a). *Interpretative document No. 6: energy economy and heat retention*. Brussels, European Commission (<http://ec.europa.eu/enterprise/construction/internal/intdoc/idoc6.htm>, accessed 15 May 2009).

European Commission (2002b). *The Sixth Framework Programme in brief*. Brussels, European Commission (http://ec.europa.eu/research/fp6/pdf/fp6-in-brief_en.pdf, accessed 19 May 2009).

European Parliament, Council of the European Union (2003). Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. *Official Journal*, L001:65–71

Franchi M et al. (2004). *Towards healthy air in dwellings in Europe. The THADE report*. Brussels, European Federation of Allergy and Airways Diseases (<http://www.efanet.org/activities/documents/THADEReport.pdf>, accessed 15 May 2009).

Gajda J, Marceau M, Van Geem M (2004). *HVAC sizing methodology for insulated concrete homes*. Washington, DC, United States Department of Housing and Urban Development (<http://www.huduser.org/publications/destech/HVACsizing.html>, accessed 15 May 2009).

Gunnbjörnsdóttir MI et al. (2006). Prevalence and incidence of respiratory symptoms in relation to indoor dampness: the RHINE study. *Thorax*, 61:221–225.

HEAL (2009). *Directory of agencies providing information on dampness and mould to the public: a list of information sources by country*, 1st ed. Brussels, Health and Environment Alliance (<http://www.env-health.org/r/157>, accessed 25 May 2009).

HUD (2000). *Moisture problems in manufactured homes: understanding their causes and finding solutions*. New York, Manufactured Housing Research Alliance (<http://www.huduser.org/publications/pdf/moisture.pdf>, accessed 15 May 2009).

HUD (2005). *Controlling and preventing household mold and moisture problems: lessons learned and strategies for disseminating best practices – a report to Congress*. Washington, DC, United States Department of Housing and Urban Development (<http://www.hud.gov/offices/lead/library/hhts/report040105.pdf>, accessed 15 May 2009).

HUD (2009). HUD User [web site] Washington, DC, United States Department of Housing and Urban Development (<http://www.huduser.org/publications/alpha/alpha.html>, accessed 15 May 2009).

Institute of Medicine (IOM) (2004). *Dampness indoor spaces and health*. Washington, DC, National Academies Press (<http://www.nap.edu/openbook.php?isbn=0309091934>, accessed 15 May 2009).

Johansson P et al. (2005). *Kritiskt fuktillstånd för mikrobiell tillväxt på byggmaterial – kunskapsöversikt [Microbiological growth on building materials – critical moisture levels. State of the art]*. Borås, SP–Swedish National Testing and Research Institute:11 (in Swedish).

Landesgesundheitsamt Baden-Württemberg (2004). *Schimmelpilze in Innenräumen – Nachweis, Bewertung, Qualitätsmanagement*. Stuttgart, Landesgesundheitsamt Baden-Württemberg (<http://www.gesundheitsamt-bw.de/servlet/PB/show/1190712/schimmelpilze-qm12.04.pdf>, accessed 20 May 2009).

Landesgesundheitsamt Baden-Württemberg (2006). *Handlungsempfehlungen für die Sanierung von mit Schimmelpilzen befallenen Innenräumen*. Stuttgart, Landesgesundheitsamt Baden-Württemberg (http://www.gesundheitsamt-bw.de/servlet/PB/show/1154726/0204_Handlungsempfehlung_Schimmelpilze.pdf, accessed 20 May 2009).

Manufactured Housing Research Alliance (2000). *Moisture problems in manufactured homes: understanding their causes and finding solutions*. New York, Manufactured Housing Research Alliance (<http://www.huduser.org/publications/pdf/moisture.pdf>, accessed 15 May 2009).

Manufactured Housing Research Alliance (2003). *Minimizing moisture problems in homes located in hot, humid climates: response of interior air pressures to various operating conditions*. Washington, DC, Partnership for Advancing Technology in Housing (http://www.huduser.org/publications/destech/moisture_problem.html, accessed 15 May 2009).

Moriske H-J, Szewzyk R (2003). *Leitfaden zur Vorbeugung, Untersuchung, Bewertung und Sanierung von Schimmelpilzwachstum in Innenräumen*. Berlin, Umweltbundesamt, (<http://www.umweltdaten.de/publikationen/fpdf-l/2199.pdf>, accessed 20 May 2009).

NAHB Research Center (2002). *Durability by design: a guide for residential builders and designers*. Washington, DC, Partnership for Advancing Technology in Housing (<http://www.pathnet.org/sp.asp?id=984>, accessed 15 May 2009).

NAHB Research Center (2009). ToolBase Resources [web site]. Upper Marlboro, MD (<http://www.toolbase.org>, accessed 15 May 2009).

National Council of the Slovak Republic (2007). 355/2007 Coll.: *Act from 21 June 2007 on Protection, Support and Development of Public Health and on Amendments and Supplements to Certain Acts*. Bratislava, National Council of the Slovak Republic (http://www.uvzsr.sk/priloha.html/592698/2/355_2007_en.pdf?html=1, accessed 20 May 2009).

Newport Partners (2006). *Moisture resistant homes: a best practice guide and plan review tool for builders and designers*. Washington, DC, Partnership for Advancing Technology in Housing (http://www.toolbase.org/PDF/DesignGuides/moisture_resistant_homes.pdf, accessed 15 May 2009).

PATH (2009). PATHnet [web site]. Washington, DC, Partnership for Advancing Technology in Housing (<http://www.pathnet.org>, accessed 15 May 2009).

PRONET [web site] (2008). What are we looking for? Arnheim, Pollution Reduction Options Network (<http://www.proneteurope.eu/index.php?page=wawlf>, accessed 15 May 2009).

Saegert SC et al. (2003). Healthy housing: a structured review of published evaluations of US interventions to improve health by modifying housing in the United States, 1990–2001. *American Journal of Public Health*, 93(9):1471–1477.

Seppänen O (2004). *Summary of opportunities to improve indoor environment in European residences to alleviate the symptoms of allergic and asthmatic children and adults*. Brussels, European Federation of Allergy and Airways Diseases Patient Associations (<http://www.efanet.org/activities/documents/THADERreport.pdf>, accessed 15 May 2009).

Umweltbundesamt (2005). *Leitfaden zur Ursachensuche und Sanierung bei Schimmelpilzwachstum in Innenräumen (Schimmelpilzsanierungs-Leitfaden)*. Dessau, Umweltbundesamt (<http://www.umweltdaten.de/publikationen/fpdf-l/2951.pdf>, accessed 20 May 2009).

Van den Hazel P, Zuurbier M, Bistrup ML, eds. (2005). *Report WP7: summary PINCHE policy recommendations*. Arnhem, the Netherlands, Public Health Services Gelderland Midden (http://www.pinche.hvdgm.nl/resource/pdf/documents/final/PINCHE_WP7_final_110106.pdf, accessed 19 May 2009).

Van den Hazel P, Zuurbier M, Busby C, eds (2005). *PINCHE project: Final Report WP6 Science-Policy Interface*. Arnhem, the Netherlands, Public Health Services Gelderland Midden (http://www.pinche.hvdgm.nl/resource/pdf/documents/final/PINCHE_WP6_final_110106.pdf, accessed 19 May 2009).

Verein Deutscher Ingenieure (1997). *Hygienic standards for ventilation and air-conditioning systems – offices and assembly rooms*. Düsseldorf, Verein Deutscher Ingenieure (Association of German Engineers)(VDI 6022).

Weiland SK et al. (2004). Climate and the prevalence of symptoms of asthma, allergic rhinitis, and atopic eczema in children. *Occupational and Environmental Medicine*, 61(7):609-615.

WHO Regional Office for Europe (2005). *Final conference report: fourth Ministerial Conference on Environment and Health, Budapest, Hungary, 23-25 June 2004*. Copenhagen, WHO Regional Office for Europe (<http://www.euro.who.int/document/e86313.pdf>, accessed 15 May 2009).

WHO Regional Office for Europe (2008a). *Development of WHO guidelines for indoor air quality: dampness and mould. Report on a working group meeting, 17–18 October 2007*. Copenhagen, WHO Regional Office for Europe (<http://www.euro.who.int/Document/E91146.pdf> , accessed 19 May 2009).

WHO Regional Office for Europe (2008b). *Interventions and actions against dampness and mould: a review of case studies*. Copenhagen, WHO Regional Office for Europe (<http://www.euro.who.int/document/HOH/allcasestudies.pdf> , accessed 17 May 2009).

WHO Regional Office for Europe (2008c). *Interventions and actions against dampness and mould. Report on a WHO working group meeting, 28–29 February 2008, Bonn, Germany*.

Copenhagen, WHO Regional Office for Europe (<http://www.euro.who.int/Document/E91664.pdf>), accessed 17 May 2009).

WHO Regional Office for Europe (2008d). WHO Indoor air quality guidelines: dampness, mould and ventilation [web page]. Copenhagen, WHO Regional Office for Europe (http://www.euro.who.int/air/activities/20070814_1), accessed 15 May 2009).

WHO Regional Office for Europe (2009a). *WHO guidelines for indoor air quality: dampness and mould*. Copenhagen, WHO Regional Office for Europe (<http://www.euro.who.int/document/e92645.pdf>), accessed 21 July 2009).

WHO Regional Office for Europe (2009b). *Damp and mould: Health risks, prevention and remedial actions. Information brochure*. Copenhagen, WHO Regional Office for Europe (http://www.euro.who.int/Housing/support/20080403_1), accessed 15 May 2009).

Zock JP et al. (2002). Housing characteristics, reported mold exposure, and asthma in the European Community Respiratory Health Survey. *Journal of Allergy and Clinical Immunology*, 110:285-292.

Zuurbier M et al. (2007). The environmental health of children: priorities in Europe. *International Journal of Occupational Medicine and Environmental Health*, 20(3):291–307.

Annex 1. Summary of recent recommendations on dampness and mould policies

WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR EUROPE

WELTGESUNDHEITSORGANISATION
REGIONALBÜRO FÜR EUROPA



ORGANISATION MONDIALE DE LA SANTÉ
BUREAU RÉGIONAL DE L'EUROPE

ВСЕМИРНАЯ ОРГАНИЗАЦИЯ ЗДРАВООХРАНЕНИЯ
ЕВРОПЕЙСКОЕ РЕГИОНАЛЬНОЕ БЮРО

WHO expert meeting on policy recommendations on interventions and actions against dampness and mould

Bonn, Germany, 9 - 10 February 2009

Findings and recommendations on dampness and mould policies made by other international projects

Contents

Introduction	64
Towards healthy air in dwellings in Europe	65
WHO indoor air quality guidelines	70
European Environment and Health Information System project	72
Directive 2002/91/EC of the European Parliament and of the Council on the Energy Performance of Buildings	73
Pollution Reduction Options NETwork	75
EnVIE	77
Policy Interpretation Network on Children's Health and Environment	79
United States Department of Housing and Urban Development report to Congress	81
Institute of Medicine report Dampness Indoor Spaces and Health	84
Results from international studies on dampness and mould	87
Examples of national guidance tools	89
Summary	92
Appendix 1. Summary of technical recommendations	93

**Prepared by
Dr Iris Kompauer
WHO Collaborating Centre on Housing and Health**

Introduction

This report summarizes and presents the major findings, results and recommendations on health-related dampness and mould challenges in the built environment that were put forward by recent European and international projects and consortiums.

From five documents – the THADE report *Policies and actions concerning indoor air pollution in dwellings in Europe and overseas* (Carrer, Rameckers & Kotzias, 2003), the United States Department of Housing and Urban Development report to Congress *Controlling and preventing household mold and moisture problems: lessons learned and strategies for disseminating best practices* (HUD, 2005), the *WHO Guidelines for Indoor Air Quality: Dampness and Mould* (WHO Regional Office for Europe, 2009a), the Institute of Medicine (IOM) report *Dampness indoor spaces and health* (IOM, 2004), and from the EnVIE project – substantial information on policy-related outcomes is available. This information should be considered when developing policy advice and recommendations on technical and policy actions and interventions against dampness and mould.

Additionally, the results of various reports of EU projects and publications from national or international studies were reviewed, with some also providing information on dampness and mould that could be useful for deriving more general conclusions and recommendations.

This summary report aims to support discussions at the WHO expert meeting on 9–10 February 2009 in Bonn. It will provide an overview of the guidance already developed and, therefore, will define a starting point for further discussion.

Towards Healthy Air in Dwellings in Europe

Project description and general findings

The main objectives of the project Towards Healthy Air in Dwellings in Europe (THADE) were:

- to collect evidence-based data on exposure to indoor air pollution and its adverse effects on health;
- to review cost-effective measures and technology to improve indoor air quality;
- to produce maps of pollutants in dwellings;
- to compile a survey of legislation and guidelines on indoor air pollution; and
- to recommend an integrated strategy that defines appropriate indoor air quality policies for implementation in Europe.

THADE report 1: Towards healthy air in dwellings in Europe. The THADE report.

Technical recommendations

In the main publication of the project – *Towards healthy air in dwellings in Europe. The THADE report* (Franchi et al., 2004) – the study group concluded that, although there is a lot of scientific information on healthy buildings, very little has been realized. The group recommended a series of actions to prevent, reduce or eliminate the adverse effects on health of poor air quality, which can be divided into five main categories. Four of these actions are relevant to mould and moisture: (a) improve ventilation and heating; (b) control moisture to avoid microbial growth; (c) improve cleaning methods and housing hygiene; and (d) avoid wall-to-wall carpeting.

Policy recommendations

Besides other measures, the members of the study group recommended better building codes and guidelines for moisture control, and education and information campaigns. They noted that although measures related to moisture control and ventilation are not independent of cultural and climate differences, European guidelines should be developed. In many European countries guidelines, actions and programmes related to indoor air quality in buildings already exist – mainly as legislation, codes and norms, research projects and public information. These actions, however, are usually targeted at a specific topic rather than at an overall national strategy. The members of the study group proposed several measures, of which mainly two bear upon mould and dampness: (a) better building codes for the new construction, especially with regard to ventilation and moisture control; and (b) promotion of research on indoor air quality in buildings, especially with regard to health effects and prevention. In collaboration with professional societies, guidelines on mould and dampness should be developed at European and national levels, for example:

- on ventilation in residential and non-residential buildings to control pollutants generated indoors;
- on control of moisture in buildings, to avoid problems related to mould;
- on how the public should check and control the indoor environment of their home;
- on the operation and maintenance of buildings; and
- on heating and cooking to avoid moisture problems.

THADE report 2: policies and actions concerning indoor air pollution in dwellings in Europe and overseas

Another THADE report, *Policies and actions concerning indoor air pollution in dwellings in Europe and overseas* (Carrer, Rameckers & Kotzias, 2003), reviewed legislation and guidelines on air pollution and air quality in dwellings in Europe and outside Europe. In total, the following were reviewed:

- guidelines and laws, actions and research programmes, and national literature of 19 European countries;
- seven projects and studies of the EU;
- initiatives of the international organizations WHO and the North Atlantic Treaty Organization Committee on the Challenges of Modern Society;
- initiatives of four international scientific societies: the International Society of Indoor Air Quality, the International Commission on Occupational Health, the European Academy of Allergology and Clinical Immunology, and the European Respiratory Society;
- experiences outside Europe (the United States Environmental Protection Agency, the National Institute for Occupational Safety and Health, Indoor Air Quality Standards in China, the American Lung Association, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the California Department of Health Services, and the Canadian Department of National Health and Welfare); and
- public web sites.

Most Member States of the EU report guidelines and/or laws, actions and/or research programmes and national literature on indoor air quality, most being from the Scandinavian countries Finland and Sweden. From Greece, Ireland and Luxembourg, and six relatively new Member States in eastern Europe, no actions on indoor air quality are reported.

Also, the THADE policy report gives special requirements on dampness, which are concerned with the protection of the health of occupants and users from the adverse effects of excessively low or high moisture levels.

Technical recommendations

Indoor humidity in the air can be controlled by:

- increasing or decreasing air temperature (heating, insulation, cooling)
- ventilation of rooms (natural or mechanical)
- humidification and dehumidification of indoor air and incoming air
- removal or reduction of moisture at its source or isolation of moisture generating activities.

Dampness on indoor surfaces and/or inside building products may be controlled by protecting the structure from external sources. Also, infiltration and penetration of rain, snow or groundwater into the structure should be avoided.

Walls and floors should prevent moisture from the ground from entering the building and carrying this moisture to any part that would be damaged by it. External walls and roofs should also resist the penetration of rain and snow to the inside of the building, should not be damaged

by rain and snow, and should not carry rain and snow to any part that would be damaged by them.

Cladding materials for external walls and roofs may be impervious (they let no water or vapour through), weather resistant and moisture resistant. Floors next to the ground should prevent ground moisture from reaching the upper surfaces of the floor, which should not be damaged by such moisture.

Surface condensation is prevented by ensuring that the relative humidity of the air close to the surface is below acceptable levels. This is achieved by an appropriate combination of heating, insulation and ventilation.

Fungicidal surface treatment may, in certain cases, help to prevent mould growth; however, this treatment is usually a temporary measure used when design measures to avoid dampness are not applicable.

To achieve a vapour pressure below the saturation point within building components, products should be suitably designed and materials should be chosen carefully. If deposition cannot be prevented, it should be kept within acceptable limits, taking into account the sensitivity of materials used, their position within the envelope and the time required for evaporation.

The following technical specifications are mentioned in the THADE policy report: construction works (category A) and construction products (category B). For *construction works*, harmonized technical specifications may be needed for the following:

- **to control humidity in the air of the building:** reference methods to calculate the humidity level as a function of the climate the dampness production rate, the products used and the ventilation rates, depending on the type of the works and the use of the works or room; and
- **to provide moisture proofing from inside dampness:** reference methods to calculate the expected condensation on surfaces and inside products, the calculation of the amount of condensation water and the expected rate of evaporation, taking into account, if needed, different climates and ventilation rates.

For construction products, the following products or product families listed in Table A1.1 are involved in dampness control, and the characteristics necessary for satisfactory performance in relation to health and hygiene are also listed in the table. Harmonized technical specifications are required to measure these characteristics or to calculate performance where technology permits, taking into account the type of construction works, their use, the intended use of the products and the climate and groundwater conditions.

Building products include all building elements exposed to precipitation (rain, snow, hail), groundwater and other dampness from surfaces in contact with the outside, such as walls, windows, roofs and ground floors, as well as their components and materials for lining, insulation, damp-proof membranes, paints and varnishes, and sealants.

Table A1.1. Products or product families involved in dampness control

Product or product family	Necessary characteristics
Heating equipment (including boilers and heating apparatuses, radiators, heat emitters, heating control devices)	Output and heat transfer
Air-conditioning and ventilation equipment (excluding humidifiers)	Airflow and pressure difference performance Rate and control of water vapour production and reduction
Insulating materials: products used to insulate elements separating heated rooms from rooms at lower temperature, such as walls to the outside or to staircases, windows, roofs and ground floors	For thermal characteristics and design aspects, see <i>Interpretative document No. 6: energy economy and heat retention</i> (European Commission, 2002a).
Fungicides for surface treatment	Effectiveness
Walls, walling materials	Vapour permeability Moisture resistance Water tightness, water diffusivity Thermal characteristics
Curtain walling, cladding materials, cladding systems	Vapour permeability Water tightness Resistance of joints to penetration of rain and snow
Roofs, roofing materials	Vapour permeability Capacity for adsorption, absorption, desorption Moisture resistance Water tightness, water diffusivity Thermal characteristics (see European Commission, 2002a)
Ground floors (solid, suspended), basement floors (including concrete, hard-core material, insulation)	Moisture resistance Thermal characteristics (see European Commission, 2002a) Vapour permeability
Damp-proof courses, damp-proof membranes (including slates, polythene, pitch polymer, sheet copper, engineering bricks, chemical injection fluid)	Vapour permeability Moisture resistance Water tightness, water diffusivity
Vapour proof membranes	Vapour permeability Moisture resistance
Insulating material (including cavity insulation)	Vapour permeability Performance of joints Moisture resistance Thermal and design aspects (see European Commission, 2002a)
Copings	Resistance to water, Performance of joints
Damp-proof trays	Imperviousness to water

Source: THADE project

Policy recommendations

The members of the study group made general recommendations for healthy air in dwellings. They recommended that constructing and maintaining healthy buildings requires cooperation between all parties (scientists, public authorities, designers, contractors, administrators and users). They also recommended that a complete guideline should include:

- target values for indoor air quality and climate;
- requirements for heating, ventilation and air-conditioning;
- requirements for construction methods, operation, and maintenance and use of buildings;
- emission criteria for finishing materials; and

- recommendations about measures people can take to preserve or improve air quality in dwellings.

The report also stated that:

Actions or programmes related to indoor air quality in dwellings are in place in many countries. The main strategies of implementation include: legislation, codes and norms, research projects and general public information. These actions more often consist of programmes targeted to a specific topic or issue, and they take the form of comprehensive national plans. The difficulty in setting up global policies and programmes on indoor air quality stems from the partition of jurisdiction that indoor air problems have in governments and local authorities. In practice, comprehensive national programmes have to necessarily involve many different governmental departments and integrate various levels of political and technical responsibility. Particularly in large countries, actions and programmes are planned and managed also at the regional, county and/or municipal level.

WHO indoor air quality guidelines

Project description and general findings

The WHO indoor air quality guidelines for dampness and mould are based on a comprehensive review and evaluation by a multidisciplinary group of experts of the accumulated scientific evidence on the adverse effects on health of indoor air pollutants, as well as on the identification of the factors that contribute to microbial growth indoors. The WHO guidelines and the evidence documentation were published in 2009 (WHO Regional Office for Europe, 2009a). The meeting report of 2007 (WHO Regional Office for Europe, 2008a) with the recommendations made by the expert group is available as a background document.

Sufficient epidemiological evidence is available from studies conducted in different countries and different climates to show that the occupants of dampness or mouldy buildings, both houses and public buildings, are at increased risk of respiratory symptoms, respiratory infections and exacerbation of asthma. Some evidence suggests increased risks of allergic rhinitis and asthma. Results from the few intervention studies available show that remediation of dampness problems can reduce adverse health outcomes.

The prevalence of indoor dampness varies widely within and among countries, continents and climate zones. It is estimated to affect 10–50% of indoor environments in Australia, Europe, India, Japan and North America. In certain settings, such as river valleys and coastal areas, dampness is substantially more severe than the national average.

The amount of water available on or in materials is the most important trigger of the growth of microorganisms, including fungi, actinomycetes and other bacteria. Microorganisms are ubiquitous. Microbes propagate rapidly wherever water is available. The dust and dirt normally present in most indoor spaces provide sufficient nutrients to support extensive microbial growth. While mould can grow on all materials, selection of appropriate materials can prevent dirt accumulation, moisture penetration and mould growth.

Microbial growth may result in greater numbers of spores, cell fragments, allergens, mycotoxins, endotoxins, β -glucans and microbial volatile organic compounds in indoor air. The causative agents of the adverse effects on health have not been identified conclusively, but an excess level of any of these agents in the indoor environment is a potential health hazard.

Microbial interactions and moisture-related physical and chemical emissions from building materials may also play a role in dampness-related adverse effects on health. Moreover, building standards and regulations with regard to comfort and health do not sufficiently emphasize requirements for preventing and controlling excess moisture and dampness.

Recommendations

The WHO indoor air quality meeting report made the following seven recommendations.

1. Persistent dampness and microbial growth on interior surfaces and in building structures should be avoided or minimized, as it may lead to adverse effects on health.
2. Indicators of dampness and microbial growth include the presence of condensation on surfaces or in structures, visible mould, perceived mould odour and a history of water damage, leakage or penetration. Thorough inspection and – if needed – appropriate

measurements may be used to confirm indoor problems related to moisture and microbial growth.

3. Currently, the relationship between dampness, exposure to microbes and adverse effects on health cannot be precisely quantified, so no quantitative health-based guideline values or thresholds can be recommended for acceptable levels of specific microorganism contamination. Instead, it is recommended that dampness and mould-related problems be prevented. When they occur, they should be remediated, because of the increased risk of hazardous exposures to microbes and chemicals.
4. Well-designed, -constructed and -maintained building envelopes are critical to the prevention and control of excess moisture and microbial growth. Such building envelopes avoid thermal bridges and prevent intrusion by liquid- or vapour-phase water. Management of moisture requires proper control of temperature and ventilation, to avoid high humidity, condensation on surfaces and excess moisture in materials. Ventilation should be distributed effectively in spaces, and stagnant air zones should be avoided.
5. Building owners are responsible for providing healthful workplaces or living environments that are free of excessive moisture and mould problems. They can do so by ensuring proper building construction and maintenance. Occupants are responsible for managing water use, heating, ventilation and appliances in a proper manner that does not lead to dampness and mould growth.
6. Local recommendations in different climate regions should be updated to control dampness-mediated microbial growth in buildings and to ensure the achievement of desirable indoor air quality.
7. Dampness and mould may be particularly prevalent in poorly maintained housing for low-income people. Remediation of conditions related to adverse exposures should be given priority, to prevent additional contributions to poor health in populations already living with an increased burden of disease.

In the appendix of the WHO report, technical recommendations are summarized in boxes and tables. Of particular relevance are the following:

- Box 3. Specific criteria for ventilation systems;
- Table 2. Critical relative humidity for various groups of materials;
- Table 3. Methods for controlling moisture for control of dust mites and microbial growth in new buildings with better building codes; and
- Table 4. Methods for controlling moisture in existing buildings.

These are included in Appendix 1 of this background document.

European Environment and Health Information System project

Project description and general findings

The European Environment and Health Information System (EHIS) project, an information system co-funded by the European Commission and coordinated by the WHO Regional Office for Europe, was established to monitor the environment and health situation and trends and to evaluate the effectiveness of relevant policies in the countries of the pan-European Region. Within this project, a document on *Children living in homes with problems of dampness* was compiled (EHIS, 2008).

The present summary uses self-reported data on dampness and mould collected by Eurostat along with information on the environment and its health context, information on policy relevance and context, and an assessment of the situation in the WHO European Region.

The authors found a great variation in exposure to dampness in the home, ranging between 4% and 40% in European countries. The data collected by the EU SILC survey (Statistics on Income and Living Conditions) show a much higher number of dampness homes in the new eastern European Member States of the EU than in the older Member States.

In general, between 1995 and 2006, there was a trend towards reduced exposure in European countries. In Italy, however, the proportion of the total population living in homes with self-reported problems of dampness nearly doubled within this period.

Differences between countries may be due to a combination of factors, including climate, socioeconomic status, housing characteristics, culture and lifestyle, and the existence and effectiveness of related policies – for example, those on ventilation or thermal insulation.

With regard to policy relevance and context, the authors found that the problems with dampness housing in European countries have been addressed partly by technical building codes and partly by hygiene requirements. The aim of the latter is to ensure that conditions are not hazardous to life. A requirement for protection against excessive humidity, however, is frequently omitted. Also, several European countries have public health services that carry out health inspections of dwellings according to specific guidelines. In general, existing policies aim to ensure habitable and healthy housing conditions, but they do not include specific health promotion objectives.

Some examples of approaches taken by different countries are given in the report. For example, Portugal has developed a project on housing and health action plans as a national follow-up to the Fourth Ministerial Conference on Environment and Health in 2004 (WHO Regional Office for Europe, 2005). Finland, one of the countries with the lowest exposure to dampness housing, addresses dampness in its Land Use and Building Act, and the United Kingdom has developed a Housing Health and Safety Rating System in which residential buildings are evaluated on the basis of their risk to health, with dampness and mould being one of the major issues addressed.

The differences between countries may, to some extent, be due to the existence and implementation of policies for preventing dampness in homes. The responsibility for avoiding or reducing dampness is largely left to the individual or household. With free housing markets, households that are vulnerable due to socioeconomic status are likely to be at risk, as they will be restricted to low-quality housing and are likely to suffer from greater problems.

Directive 2002/91/EC of the European Parliament and of the Council on the energy performance of buildings

This Directive, on building energy performance (European Parliament, Council of the European Union, 2003), was issued in December 2002. It obliges Member States to apply minimum requirements to the energy performance of new and existing buildings, ensure the certification of their energy performance and require the regular inspection of boilers and air-conditioning systems in buildings. The Directive therefore has a direct effect on indoor conditions. The four key points of the Directive are:

1. a common methodology for calculating the integrated energy performance of buildings;
2. minimum standards on the energy performance of new buildings and of existing buildings that are subject to major renovation;
3. systems for the energy certification of new and existing buildings and, for public buildings, the prominent display of this certification and other relevant information, with certificates being valid for less than five years; and
4. regular inspection of boilers and central air-conditioning systems in buildings and, in addition, an assessment of heating installations in which the boilers are more than 15 years old.

Scope

The Directive concerns the residential sector and the tertiary sector (such as offices and public buildings). The scope of the provisions on certification does not, however, include some buildings, such as historic buildings and industrial sites. It covers all aspects of energy efficiency in buildings in an attempt to establish a truly integrated approach.

Certificates, minimum standards and inspections

Energy performance certificates should be made available when buildings are constructed, sold or rented out. The Directive specifically mentions rented buildings with the aim of ensuring that the owner, who does not normally pay the charges for energy expenditure, should take the necessary action.

Background

Items 16, 19 and 20 of the Directive, along with its Article 4, provide the background. Item 16 of the Directive states the following:

(16) The certification process may be supported by programmes to facilitate equal access to improved energy performance; based upon agreements between organisations of stakeholders and a body appointed by the Member States; carried out by energy service companies which agree to commit themselves to undertake the identified investments. The schemes adopted should be supervised and followed up by Member States, which should also facilitate the use of incentive systems. To the extent possible, the certificate should describe the actual energy-performance situation of the building and may be revised accordingly. Public authority buildings and buildings frequently visited by the public should set an example by taking environmental and energy considerations into account and therefore should be subject to energy certification on a regular basis. The dissemination to the public of this information on energy performance should be enhanced by clearly displaying these energy certificates. Moreover, the displaying of officially recommended indoor temperatures, together with the actual measured temperature, should discourage the misuse of heating, air-conditioning and ventilation systems. This should contribute to avoiding unnecessary use

of energy and to safeguarding comfortable indoor climatic conditions (thermal comfort) in relation to the outside temperature.

Item 19 of the Directive states the following:

(19) Regular maintenance of boilers and of air-conditioning systems by qualified personnel contributes to maintaining their correct adjustment in accordance with the product specification and in that way will ensure optimal performance from an environmental, safety and energy point of view. An independent assessment of the total heating installation is appropriate whenever replacement could be considered on the basis of cost-effectiveness.

Item 20 of the Directive states the following:

(20) The billing, to occupants of buildings, of the costs of heating, air-conditioning and hot water, calculated in proportion to actual consumption, could contribute towards energy saving in the residential sector. Occupants should be enabled to regulate their own consumption of heat and hot water, in so far as such measures are cost effective.

Article 4, setting of energy performance requirements, states the following:

1. Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings are set, based on the methodology referred to in Article 3. When setting requirements, Member States may differentiate between new and existing buildings and different categories of buildings. These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building. These requirements shall be reviewed at regular intervals which should not be longer than five years and, if necessary, updated in order to reflect technical progress in the building sector.

2. The energy performance requirements shall be applied in accordance with Articles 5 and 6.

3. Member States may decide not to set or apply the requirements referred to in paragraph 1 for the following categories of buildings:

- buildings and monuments officially protected as part of a designated environment or because of their special architectural or historic merit, where compliance with the requirements would unacceptably alter their character or appearance,
- buildings used as places of worship and for religious activities,
- temporary buildings with a planned time of use of two years or less, industrial sites, workshops and non-residential agricultural buildings with low energy demand and non-residential agricultural buildings which are in use by a sector covered by a national sectoral agreement on energy performance,
- residential buildings which are intended to be used less than four months of the year,
- stand-alone buildings with a total useful floor area of less than 50 m².

Pollution Reduction Options NETwork

According to the background material provided on the Pollution Reduction Options NETwork (PRONET) web site (PRONET, 2008),

“The main aim of the PRONET project is to facilitate exchange and evaluation of interventions on environment and health exposure reduction measures on a regional level and promote implementation of successful initiatives in other regions of Europe. This project will focus on the exchange of useful practices in two areas:

- the reduction of traffic-related health hazards (air pollution and noise) and
- improvement of indoor air quality.”

Within this project, case studies are collected and evaluated. By building up a network, the initiators want to “improve communication between the different Member States, European Regions and organisations on these topics” (PRONET, 2008).

Pronet Work Package 1 (Indoor Environment) was introduced in March 2007. In November 2007, the first workshop on indoor environment was conducted in Barcelona, Spain, and on 9–10 June 2008, the second workshop on indoor environment was conducted in Copenhagen, Denmark. A major part of the second workshop was devoted to discussing the preliminary assessment of the case studies identified so far.

In an approach to sustainable building designs taken by the Municipality of Copenhagen, a building code has been developed, which is mainly intended for the Municipality of Copenhagen, but many other municipalities have already shown interest or used it as well. Major private developers have also been approached, but they showed less interest, partly because they work according to their own standards. Incorporating indoor guidelines in this building code has been shown to be a major challenge, for the following particular reasons:

- the complexity and multiplicity of aspects involved
- lack of clear criteria that should be fulfilled
- influence of occupant behaviour.

To help incorporate indoor guidelines in the next edition of the building code, the following information is needed from the indoor air community:

- a list of materials that are good or bad for the indoor environment
- specified standards or goals/targets.

Currently, drafts of three fact sheets with studies aimed at reducing dampness and mould have been prepared.

The first fact sheet includes two studies and is targeted at heating and insulation improvement in homes in the United Kingdom. In the first study – after installation of central heating, improved ventilation, improved insulation through the use of double glazed doors, re-roofing and electrical upgrading – houses were warmer and dampness declined. Also, a reduction in asthma attacks and health service costs and an improvement in the quality of life were observed. The second study was on asthmatic children living in dampness council houses. After improvement of the heating system, respiratory symptoms were significantly reduced and less time was lost from school.

Concerning applicability, the cost per house varies between about €3 000 (for installing central heating) and €6 000–10 000 (for heating in combination with all other measures). Important aspects of these projects include the involvement of the community and maintaining adequate air exchange rates when insulating homes. Insulation should be used as a means of preventing excess humidity, not just thermal improvement.

The second fact sheet, from the United States Environmental Protection Agency (EPA), describes the Indoor Air Quality Tools for Schools programme (EPA, 2009). The programme was developed to help schools prevent, identify and resolve indoor air quality problems through simple, low-cost measures and has been evaluated in several schools. Health complaints, respiratory and asthma-related incidents and adverse effects on health and absenteeism were reduced following implementation. The authors assume that some adjustments might be necessary when transferring this study to European countries. Also, the school staff needs to be actively involved in the measures.

In the third fact sheet, completely renovated schools were compared to partially renovated schools. A reduction in mould concentrations was only observed in the completely renovated schools. The authors assessed costs up to €2–3 million, depending on the size of the problem and the amount of repairs needed. During renovation, the presence of symptomatic children should be avoided. Remediative work should be done by a professional company, which can also be said for the home environment.

EnVIE

Project description and general findings

EnVIE is a co-ordinated action on indoor air quality and health effects and is supported by the Sixth EU Framework Programme for Research and Technological Development (European Commission, 2002b). From 12 to 13 June 2007, the first EnVIE Conference on Indoor Air Quality and Health for EU Policy took place in Helsinki, Finland, and the papers of the presentations have been published in the proceedings (de Oliveira Fernandes et al., 2007).

Technical recommendations

De Oliveira Fernandes, Leal & Craveiro (2007:109–118) reported a study on the occurrence of condensation conducted in a reference room. From their experiment, they drew three main conclusions.

1. To prevent condensation, a combination of three measures on insulation, ventilation and temperature heating set point is necessary. They found a hierarchy in the effectiveness of measures, with temperature set point being the most important, followed by ventilation rate and level of insulation.
2. Thermal bridges in the envelope increase the risk of condensation; therefore, particular care should be taken in the continuity of the insulation. External insulation should be preferred. It is always possible to decrease that risk by increasing the heating set point and/or the ventilation rate, but this is likely to mean a (unnecessary) significant impact on the energy demand.
3. Ventilation rates of about 30 m³ per hour per person (stated by good-practice guidelines and standards), when combined with reasonable insulation and set points and with the absence of thermal bridges, are sufficient to remove the vapour produced by the occupants and to prevent condensation. Even lower ventilation rates seem to be compatible, so to prevent condensation it does not seem to be crucial to set the ventilation rates.

In the Final Report of the EnVIE project, the authors point out that dampness buildings have been known to pose a health hazard for centuries. A combination of (a) the practice of hiding water and sewage piping in the structures, (b) flat roofs in wet and cold climate zones, (c) reduced ventilation rates, and (d) building renovation by sealing old building structures under new vapour barriers and insulation materials in response to the energy crises of the 1970s and 1980s brought dampness buildings into indoor air quality focus in the 1990s.

Dampness building materials may give rise to volatile substances formed during secondary reactions. Examples are aldehydes from dampness mineral wool or aldehydes and odorous carboxylic acids from linoleum, especially if it is washed incorrectly with strong detergents that damage the surface layer of the floor covering.

Also, moisture induced chemical degradation of flooring materials on dampness alkaline concrete might occur. In the case of vinyl flooring and floor adhesive laid on dampness alkaline concrete, this combination may give rise to the formation of odorous alcohols (mainly C₁₀₋₁₂). The phthalate plasticizer content in resilient vinyl floor coverings can amount to 30% of the weight of the material. The chemical degradation of the plasticizer is strongly accelerated by the presence of alkali. In addition, phthalate plasticizers can contain small traces of alcohol components. The adhesives frequently used for laying floor coverings are often based on acrylate

copolymers of ethylhexacrylate, which can be hydrolysed by dampness alkaline concrete, thus forming odorous alcohol.

When they leak, water and sewage systems become indoor air quality issues – in particular, when the water leakage in building structure remains hidden for a long period of time. Condensation on building surfaces and also hidden structures may repeatedly and continuously occur if cold surfaces are combined with high humidity, insufficient or non-existent ventilation in the kitchen or bathroom or seepage of groundwater through porous materials. Such condensation may be due to inappropriate building site, poor site drainage and improper construction. Quite small quantities of leaked or condensed water may keep large structures wetted.

The following recommendations should be followed to reduce or prevent dampness and mould.

- Water and sewage pipes for new buildings and buildings undergoing renovation of piping should be installed in a way that safely drains any leaks or makes them apparent immediately.
- Dishwashers and laundry machines that are not located in bathrooms should be equipped with automatic water shutoff and alarm systems for any water leaks.
- Bathrooms and laundry washing and drying spaces should be built with watertight sloped floors, floor drains and exhaust ventilation (also in the kitchen), which does not recirculate the air into other rooms.
- Ventilation systems – including kitchen, laundry and bathroom extraction fans – should be controlled according to indoor and/or outdoor temperature and moisture.
- Building walls, ceilings and attics should be designed to resist predictable quantities of condensed or leaked moisture and to dry by convective and/or natural air circulation. This requires that their constructions are not tightly sealed but provide ways for air to enter and exit and provide sufficient space for convective airflow in between the walls.
- Building envelopes and windows should be properly insulated, to avoid cold bridges and prevent condensation.

Policy recommendations

Among the policy recommendations made by the members of the study group are the following.

- Regular maintenance and inspection of all ventilation and air-conditioning systems, and of all water and drainage systems, should be mandated.
- Systematic documentation and operating, inspection and maintenance manuals for buildings and all installations that may damage the building, including a layout plan of the water and sewage system, should be provided to the building owner, occupant and manager.
- A sufficiently qualified and trained person should be assigned both control of this documentation and responsibility for all building related tasks.
- European moisture control guidelines should be provided for building design and maintenance, to prevent persistent dampness and hidden and visible mould growth.

Policy Interpretation Network on Children’s Health and Environment

Project description and general findings

The Policy Interpretation Network on Children’s Health and Environment (PINCHE) was a multidisciplinary network of representatives from science, industry, nongovernmental organizations and consumer–patient organizations in Europe. It was set up and funded by the EU for three years, from January 2003 to January 2006. Its aim was to identify environmental risk factors to which children are susceptible or have an increased risk of exposure and to provide a prioritized list of risk factors and policy recommendations for action (Zuurbier et al., 2007).

In general, PINCHE gave a high priority – with an urgent need for action – to outdoor air pollutants (especially those that were traffic related), environmental tobacco smoke, allergens and mercury. Among other environmental stressors, mould was classified as being of medium priority, because exposure to mould (or associated types of exposure) leads to respiratory problems. The project group concluded that no specific susceptibility of children to mould, compared with that of adults, is suspected. All children are exposed to mould indoors, and many households face problems with mould indoors.

Concerning health risks, exposure to mould leads to increased asthma symptoms and, in addition, mould growth could be a marker for other types of exposure. Concerning guidelines and legislation, the report states that there is no legal regulation for mould. To raise the awareness on the importance of ventilation in houses and public buildings, the development of guidelines and regular inspections of schools, kindergartens, and day-care facilities should be given priority.

Technical recommendations

The *PINCHE project: final report WP6 science-policy interface* (Van den Hazel, Zuurbier & Busby, 2005) made the following recommendations for research and monitoring.

- The impact of fungal contaminants on child health should be investigated and causal relationships should be established.
- The influence of the household environment on the respiratory health of children should be studied more, to establish safe limit values for guidelines for indoor exposure, especially in dwellings. The effects of both short- and long-term exposure at home should be studied.
- Collaboration of research institutions and patient’s organizations should be strengthened, to carry out updated epidemiological surveys.

Policy recommendations

The *PINCHE project: final report WP6 science-policy interface* also made the following policy recommendations (Van den Hazel, Zuurbier & Busby, 2005).

- On the national and local level, specific guidelines should be developed on how to control moisture and how to ventilate dwellings, schools, day-care facilities, recreational buildings, and public buildings.
- On the national and local level, ventilation and indoor air quality should be monitored regularly by using adequate indicators.

- On the EU and national levels, there is a need for guidelines, recommendations and regulations for improvement of the indoor environment, including those for ventilation, heating, exchange of air, and avoidance of moisture and mould.
- Buildings should be properly designed and constructed, with periodic maintenance, to avoid water intrusion.

In *Report WP7: summary PINCHE policy recommendations* (Van den Hazel, Zuurbier & Bistrup, 2005), the members of the project recommended that, on a national level, people should be educated about how to control ventilation, temperature and humidity, so they can lower concentrations of mould and formaldehyde indoors.

United States Department of Housing and Urban Development report to Congress

Project description and general findings

The report *Controlling and preventing household mold and moisture problems: lessons learned and strategies for disseminating best practices* (HUD, 2005) describes ongoing and recently completed residential mould- and moisture-related work conducted by three offices within the United States Department of Housing and Urban Development (HUD) from 1999 to 2005:

1. the Office of Healthy Homes and Lead Hazard Control (OHHLHC)
2. the Office of Policy Development and Research (PD&R)
3. the Office of Public and Indian Housing (PIH).

Each of these offices is pursuing work within its areas of focus within HUD, while also coordinating with each other to collaborate and share findings. The results of selected projects are presented in the report, and it discusses HUD's strategies for reaching out to key groups with information about moisture control and mould prevention.

Technical recommendations: assessment of problems with moisture and mould

The authors of the HUD report mention that methods for identifying moisture and mould problems should be improved. Concerning moisture, conventional methods – such as handheld meters that rely on electrical resistance or capacitance measurements, together with visual inspection that may require removal or destruction of components to access building cavities or concealed spaces – are labour-intensive, destructive, and prone to error. Also, there is no generally accepted definition of overall dampness in a house. This hampers inspection, remediation and research. In general, mould is measured either by viable count methods or by spore counts. These techniques are time consuming and require considerable technical expertise. Also, it is difficult to interpret test results, since mould spores are ubiquitous and there is no consensus among experts about acceptable indoor spore concentrations or about which species are most problematic. Therefore, experts generally advise consumers that they do not need to test for mould in their homes, but should rather remove all mould and eliminate the underlying water source.

Several projects that respond through the development, testing, and deployment of next-generation methods for mould and moisture testing were funded and are described briefly below.

One of the three offices of HUD, PD&R, sponsored several publications, which are elements of a larger programme in support of the Partnership for Advancing Technology in Housing (PATH), a public-private partnership the goals of which encompass moisture control and moisture management. The publication *Durability by design: a guide for residential builders and designers* (NAHB Research Center, 2002) contains information for designers and builders of residences about practices that enhance the durability of homes, including resistance to mould intrusion. Specific chapters deal with groundwater and surface water, rain and water vapor, and decay and corrosion. The recommended practices do not involve mould in any direct way, but instead deal directly with moisture.

The durability recommendations cover such topics as:

- foundation drainage systems
- roof overhang sizing

- drainage-plane design for wall systems
- exhaust ventilation systems
- bathroom design considerations
- crawlspace ventilation techniques.

Other HUD-sponsored publications that deal with moisture are: *Moisture problems in manufactured homes: understanding their causes and finding solutions* (HUD, 2000); *Moisture resistant homes: a best practice guide and plan review tool for builders and designers* (Newport Partners, 2006); *HVAC sizing methodology for insulated concrete homes* (Gajda, Marceau & van Geem, 2004); and “*Building moisture and durability: past, present and future work*” (Dacquisto, Crandell & Lyons, 2004).

The latter publication contains a research agenda for future work, including project descriptions and specific research priorities, such as:

- compiling statistically valid data on the relative frequency and severity of different moisture problems in new and existing houses;
- performing an in-depth analysis of existing American Housing Survey data on moisture problems;
- characterizing the moisture performance of existing homes through a field testing protocol;
- assessing the drying performance of typical wall systems in United States’ climates and disseminating the results;
- developing educational tools to enable certification programmes that recognize good moisture control practices; and
- developing statistically validated procedures to assess internal moisture loads for use in hygrothermal analyses and related engineering studies.

This publication also included a review of possible approaches to coordinating moisture-related programmes among public agencies and private-sector organizations.

A publication that applies especially to hot and humid climates is *Minimizing moisture problems in homes located in hot, humid climates: response of interior air pressures to various operating conditions* (Manufactured Housing Research Alliance, 2003).

Policy recommendations

Chapter 4 of the report *Controlling and preventing household mold and moisture problems: lessons learned and strategies for disseminating best practices* (HUD, 2005:27–32) deals with disseminating best practices. HUD tries to create an infrastructure of housing residents, builders and contractors, housing management and maintenance staff, researchers and building scientists, and health and environmental specialists. To communicate information to these groups, HUD uses the following strategies:

- communicating through multiple channels
- strategically partnering with other organizations
- delivering information tailored for the audience
- packaging guidance in appropriate formats.

The companies that build and design homes often receive their information through non-federal sources operated by trade associations and other industry groups. These dissemination channels are used to deliver research findings – as well as best practices compiled from other sources – to industry stakeholders. One example is the ToolBase web portal (NAHB Research Center, 2009), which is operated by a subsidiary of the National Association of Home Builders.

Consumers are reached by providing information about new building technologies and performance issues on PATHnet (PATH, 2009).

Institute of Medicine report Dampness indoor spaces and health

Project description and general findings

A very comprehensive report on dampness and mould is the United States Institute of Medicine (IOM) report *Dampness indoor spaces and health* (IOM, 2004). The report examines both the adverse effects on health of exposures that result from dampness indoor environments and offers recommendations for public health interventions. Concerning health effects, the IOM Committee on Dampness Spaces and Health categorized evidence of an association between dampness indoor spaces and health into four groups.

1. Sufficient evidence of a causal relationship was not found by the Committee.
2. Sufficient evidence of an association between dampness indoor spaces and health was observed for upper respiratory (nasal and throat) tract symptoms, wheeze, cough and asthma symptoms in sensitized asthmatic people.
3. Limited or suggestive evidence of an association was found for dyspnoea (shortness of breath), asthma development and lower respiratory tract illness in otherwise healthy children.
4. Inadequate or insufficient evidence to determine whether an association exists was seen for several other outcomes reported, such as airflow obstruction in otherwise healthy people, skin symptoms, mucous membrane irritation syndrome, gastrointestinal tract problems, chronic obstructive pulmonary disease, fatigue, inhalation fevers (non-occupational exposures), neuropsychiatric symptoms, lower respiratory tract illness in otherwise healthy adults, cancer, acute idiopathic pulmonary haemorrhage in infants, reproductive effects, and rheumatological and other immune diseases.

If the effect of dampness indoor spaces and the presence of mould are considered, sufficient evidence of an association can additionally be observed for hypersensitivity pneumonitis in susceptible people. The Committee, however, notes that these conclusions are not applicable to immunocompromised people.

Chapter 6 of *Dampness indoor spaces and health* (IOM, 2004:270–310) provides an overview of prevention strategies, published guidelines for mould remediation, remediation protocols, and the effectiveness of various cleaning strategies for mould. Chapter 7 of the book, “The public health response” (IOM, 2004: 311–332), provides general recommendations on dampness and mould.

Technical recommendations

Little information is available on the efficiency and effect of prevention strategies. The Committee compared seven guidelines from six organizations. The comparison covered how the guidelines were developed, preventive actions, assessment methods, remediation activities and events that would trigger intervention activities.

The Committee found both agreement and disagreement in the recommendations of these seven guidelines. There was agreement that mould should not be allowed to colonize materials in buildings and that underlying moisture conditions should be identified and eliminated. Concerning remediation, the best way to do that is to remove mould from materials that can be effectively cleaned and to discard materials that cannot be cleaned or are physically damaged. Occupants and workers must be protected during remediation at a level that depends on the

situation. The various guidelines, however, are divided on the use of disinfectants and on how to respond to contamination in heating, ventilation and air-conditioning systems.

Policy recommendations

The Committee suspected that institutional and social barriers – one important barrier being poverty – may hinder the widespread adoption of technical measures and practices that could prevent or reduce problematic indoor dampness. The Committee identified several areas of endeavour that deserve discussion in the formulation of public health mechanisms to prevent or reduce the incidence of dampness indoor environments, as follows.

The first area is assessing and monitoring indoor environments at risk of dampness problems. There is no generally accepted definition of dampness, which is a primary challenge in formulating a public health strategy in response to indoor dampness. Studies on dampness problems or water damage show a wide range of estimates of affected houses. Therefore, the Committee recommended the development of precise, agreed-upon definitions of dampness to achieve greater uniformity and comparability of the data collected and the actions taken. Also, the determinants of dampness problems should be studied to ascertain where to focus interventions and research on its adverse effects on health. Current knowledge is insufficient to support a general assessment and monitoring effort for dampness-related agents like mould for public health policy needs.

The second area is modification of regulations, building codes, and building-related contracts to promote healthy indoor environments; and enforcement of existing rules. Existing local, state and national codes may not be sufficient to ensure that good practices are implemented. Also, many of them are based primarily on practical experience. The Committee recommended that current building codes should be reviewed and modified, as necessary. Moreover, changes in contracts might be considered that would promote building design, construction, operation and maintenance practices that reduce the potential for problems with indoor dampness or would clarify responsibilities.

The third area is the creation of incentives to construct and maintain healthy indoor environments and financial assistance for remediation, where needed. Incentives would include the following.

- Governments could provide tax incentives, low-interest loans or streamlined application procedures.
- Concerning rental properties, authorities could be given permission to levy fines if problems caused by water leaks are not corrected.
- Bonuses could be given for meeting a defined set of goals for preventing or reducing dampness-related conditions for those responsible for the maintenance of public or institutional settings. The Committee suggested that such programmes could first be tested in government-owned buildings.

The fourth area is the development, dissemination, and implementation of guidelines on building design, construction, operation and maintenance for the prevention of dampness-related problems, ideally at the national level. The following considerations should be taken into account.

- The guidelines should be formulated with input from many disciplines and a wide array of stakeholders.
- Costs and benefits of actions implemented should be assessed.
- Differences in climate, geography, building type and building age should be considered.
- The guidelines should go beyond simple prescriptive application of available science and technology. Professional judgement should be allowed.
- Draft guidelines should be reviewed externally.

The fifth area is public health oriented research and demonstration projects to evaluate the short- and long-term effectiveness of intervention strategies. The Committee noted that there is a lack of evidence on the effectiveness of various interventions on symptom reduction or on the reduction of the chances of developing asthma. The members of the Committee cite a paper by Saegert et al. (2003), where the authors observed the following factors associated with success in intervention studies:

Technological interventions appear most successful when the technology is effective, cheap and durable and requires little effort to maintain or use. Such interventions are especially effective if accompanied by behavioural or knowledge training, and if hazard amelioration can be successfully accomplished through individual-level efforts alone.

Involving people more deeply in the solution of health problems, especially by home visits, appears to be especially effective and can improve multiple health outcomes.

The sixth area is the education and training of building occupants, health professionals, and people involved in the design, construction, management, and maintenance of buildings to improve efforts to avoid or reduce dampness and dampness-related health risks. Because physicians and other health care providers are generally not well educated in the diagnosis and treatment of environmental health-related problems, the IOM identified competence objectives graduating medical students should develop. Although technical information on controlling moisture in buildings is available, experience suggests that architects, engineers, facility managers and contractors in the building trades often do not apply it. These building professionals should receive better training on the causes and prevention of dampness problems.

Results from international studies on dampness and mould

European Community Respiratory Health Survey

One study on data of the European Community Respiratory Health Survey (ECRHS) I investigated the association between housing characteristics related to dampness, exposure to mould and house dust mite levels in 38 study centres in 14 European countries and four countries outside Europe (Australia, India, New Zealand and the United States of America). Information on such housing characteristics as heating and ventilation, double glazing, floor covers, recent water damage and exposure to mould were collected by interviewers on questionnaires. Mould or mildew in the last year were reported on average by 22.1% of the participants (range: 5–56%), 12.4% (4–32%) of them reported a water damage in the last year, and 2.2% (0–16%) reported water on the basement floor (Zock et al., 2002).

The RHINE (Respiratory Health in Northern Europe) study, a follow-up study on subjects who participated in ECRHS I, found a prevalence of indoor dampness of 18% (12.2–31.6%) during the previous 12 months in northern European countries. The prevalence of visible mould was reported in 6.7% (3.5–13.6%) of the houses, wet floors in 3.8% (2.1–6.4%) of the houses and water damage in 13.4% (7.7–23.4%) of the houses (Gunnbjörnsdóttir et al., 2006).

International Study of Asthma and Allergies in Childhood

An ecological study with data from the International Study of Asthma and Allergies in Childhood showed that the prevalence of asthma symptoms increased by 2.7% with an increase in the estimated annual mean of indoor relative humidity of 10%. Mean relative outdoor humidity was not associated with asthma prevalence (Weiland et al., 2004).

Large Analysis and Review of European Housing and Health Status Survey

The Large Analysis and Review of European Housing and Health Status (LARES) study, a pan-European housing and health survey, was undertaken from 2002 to 2003 in eight European cities: Angers (France), Bonn (Germany), Bratislava (Slovakia), Budapest (Hungary), Ferreira do Alentejo (Portugal), Forlì (Italy), Geneva (Switzerland) and Vilnius (Lithuania). The survey collected information on the condition of 3373 dwellings and the health status of 8519 inhabitants.

In almost 25% of all dwellings visited, visible mould growth was detected in at least one room, with the highest mould occurrence rates in kitchens (10.5% of all dwellings) and bathrooms (14% of all dwellings). The following building characteristics were associated with the presence of visual mould growth:

- odours of dampness and condensation signs
- building age (old buildings have a higher likelihood of mould)
- floor level (mould is more prevalent on the ground floor and in the basement)
- permanent problems with temperature with the seasons
- cold indoor temperatures in winter and the use of additional heating devices.

Also, an association between the size of the dwelling and the size of the respective household has been found. The smaller the dwelling and the larger the household, the more likely is mould to be present. The LARES data, however, does not provide an indication that ventilation is associated with visual mould growth.

Pollution and the Young study

In the Pollution and the Young study, data on children aged 6–12 years from 12 cross-sectional studies in 10 European countries, North America and the Russian Federation, were pooled and analysed. The percentage of children exposed to mould ever ranged from 13.9% in the Russian Federation to 39.1% in North America; for recent exposure to mould, it ranged from 10.6% in the Russian Federation to 31.1% in North America. Information on mould in the child's bedroom was collected for only four studies. Generally, it was less prevalent and ranged from 5.3% in the Russian Federation to 7.5% in North America, meaning that 25–50% of the children exposed to mould ever also had mould in the bedroom (Antova et al., 2008).

Technical or policy recommendations are unavailable for any of these studies.

Examples of national guidance tools

Germany

Federal Environment Agency

The German Federal Environment Agency (Umweltbundesamt) published guidelines on identifying and remediating mould indoors, *Leitfaden zur Ursachensuche und Sanierung bei Schimmelpilzwachstum in Innenräumen (Schimmelpilzsanierungs-Leitfaden)* (Umweltbundesamt Dessau, 2005), which describes causes of mould growth in buildings, actions that can be conducted by the occupants, preparation of and procedures for remediation, evaluation and some examples of particular cases.

In parallel, guidelines for the prevention, investigation, assessment and remediation of mould growth indoors – *Leitfaden zur Vorbeugung, Untersuchung, Bewertung und Sanierung von Schimmelpilzwachstum in Innenräumen* (Moriske & Szewzyk, 2003) – were published. These guidelines address more directly the prevention of mould growth.

State Health Department of Baden-Württemberg

The State Health Department of Baden-Württemberg edited three documents on mould and handling moisture. The first, a rather comprehensive document, deals with the detection, evaluation and quality of mould indoors, *Schimmelpilze in Innenräumen – Nachweis, Bewertung, Qualitätsmanagement* (LGA Baden-Württemberg, 2004). It describes: the properties of mould; planning the investigation; on-site inspection; drawing and preparing samples and verifying procedures for identifying mould and its metabolites in indoor spaces; indicator organisms of damage to construction; mould with high indication of building damage; hygienic assessment; and quality assurance.

The second document, *Handlungsempfehlungen für die Sanierung von mit Schimmelpilzen befallenen Innenräumen* (Landesgesundheitsamt Baden-Württemberg im Regierungspräsidium Stuttgart, 2006), focuses on the procedures for mould remediation. The third, *Netzwerk Schimmelpilzberatung Baden-Württemberg* (Baden-Württemberg Regierungspräsidium Stuttgart Landesgesundheitsamt, 2001), addresses the issues of several types of people involved in mould problems, such as landlords and tenants, building owners, and other people affected.

Portugal

In Portugal, three laws from 2006 relate to the Energy Performance of Buildings Directive, and in January 2009 these laws came into force and were applied. The laws require that every building must have a certificate before being sold or rented, but the Portuguese certification process is expected to go beyond energy performance⁶. The certification is to be done by an expert that is also requested to measure a variety of indoor pollutants and classify the place according to the results (in the context of national maximum reference values). The pollutants measured are: PM10, carbon dioxide, carbon monoxide, ozone, formaldehyde, volatile organic compounds, radon, bacteria, fungi and *Legionella*; for all of those pollutants, the intention is to provide national reference values for the maximum concentrations. The results will provide information about energy and indoor air quality in parallel. However, no defined national

⁶ A governmental decision is pending, but all documents and measurement guidelines are prepared.

strategy exists yet on the problem of dampness and mould, and there are no national guidance tools on remediation or prevention.

Finland

Finland has several activities and materials available that contribute to a strategy. All the materials are in Finnish (and some are also in Swedish). The main documents available are:

- a guidance tool on indoor air quality problems for local health officers (used widely by others as well), including a section on microbial indoor air quality issues (Asumisterveysohje) (Ministry of the Social Affairs and Health)
- a handbook to support the use of the guidance tool, which includes, for example, detailed instructions on the measurements;
- a guide on how to manage dampness and mould-related indoor air quality problems in schools; and
- a recently published handbook on how to renovate school buildings with indoor air quality problems.

In addition to the above-mentioned documents, there are also the following current activities. A working group of the Ministry of Social Affairs and Health is working on:

- setting guideline values for office-related working environments; and
- developing good practices for solving dampness- and mould-related indoor air quality problems in workplaces.

Also, as part of the National Strategy for Building Renovation (currently being prepared), there is a section on renovations for dampness and mould problems. This project is under the Ministry of the Environment, which administers building, construction and ventilation legislation. Moreover, the Institute of Occupational Health is setting up similar tools and practices for workplaces and occupational safety officers. Furthermore, a survey of dampness and mould in day-care centres has been requested by the Ministry of Social Affairs and Health and is currently being initiated.

United States of America

Several institutions in the United States of America have published guidelines on mould and moisture problems, respectively. Some of them are listed below.

United States Environmental Protection Agency (EPA)

Basic information and resources on mould are available on the EPA Mold Resources web page. Also, the EPA has released two publications on mould and moisture.

1. *A brief guide to mold, moisture, and your home* provides information and guidance for homeowners and renters on how to clean up residential mould problems and how to prevent mould growth.
2. *Mold remediation in schools and commercial buildings* (EPA, 2001) presents guidelines for the remediation and cleanup of mould and moisture problems in schools and commercial

buildings. The guidelines include measures designed to protect the health of building occupants and remediators. It has been designed primarily for building managers, custodians and others responsible for commercial building and school maintenance.

Also, a web-based tool, the Mold Web Course, is designed primarily for environmental and public health professionals. It contains information on mould prevention and remediation. The Course has nine chapters that are further divided into smaller lessons.

United States Department of Housing And Urban Development (HUD)

HUD released several publications on moisture and mould for different target groups, some of which are described before in this document already. All publications can be downloaded from the HUD USER web site (HUD, 2009). Some examples of publications related to moisture and mould are:

- *Controlling and preventing household mold and moisture problems: lessons learned and strategies for disseminating best practices – a report to Congress* (HUD, 2005);
- *Durability by design: a guide for residential builders and designers* (NAHB Research Center, 2002);
- *Moisture problems in manufactured homes: understanding their causes and finding solutions* (Manufactured Housing Research Alliance, 2000); and
- *Moisture resistant homes: a best practice guide and plan review tool for builders and designers* (Newport Partners, 2006).

Summary

From the last meeting of WHO experts on dampness and mould, in February 2008, the case studies and other intervention studies and the projects described in this summary have produced useful results in the case of problems involving mould and moisture. For example, they have helped with finding the causes of moisture problems, removing mould and damaged materials, and improving ventilation and thermal insulation.

Also, much is known about measures to prevent mould and moisture, as they relate to the issues of construction and occupant behaviour. Successful measures that have been listed in the last meeting are summarized in the meeting report *Interventions and actions against dampness and mould* (WHO Regional Office for Europe, 2008b,d).

Concerning moisture, however, the building materials or combinations of building materials leading to moisture problems seem to be poorly understood. Also, due to the wide variety of methods used to identify mould and moisture problems, the data of various studies are very difficult to interpret.

Some studies provide estimates of the costs of the actions that were conducted in the studies, but a comprehensive cost–benefit analysis is missing completely in all studies and project descriptions. Especially with regard to budget constraints, it would be useful to know which actions provide the greatest benefit for a given budget or how a defined goal can be reached with the least resources.

Moreover, it is still unclear if there are any incentives that motivate landlords or other responsible people to act against mould and moisture – for example, whether penalties or financial incentives would be more effective.

Another problem is the spectrum of qualifications of housing professionals involved in the prevention and remediation of mould and moisture problems, such as architects, engineers, construction workers and craftsmen. Also, there appears to be a lack of structured advanced training.

Last, but not least, the effects of teaching programmes for occupants affected by problems with mould and moisture or for those interested in preventing these problems have not been evaluated thoroughly.

Appendix 1. Summary of technical recommendations

Source of all tables: WHO Guidelines for Indoor Air Quality: Dampness and Mould (WHO, 2009a).

Box 3. Specific criteria for ventilation systems**Ventilation air should be distributed and used effectively in the building.**

- Ventilation air should be distributed to the rooms of the building according to their design and use.
- In practice, therefore, the system should be designed and constructed so that air flow can be measured and balanced.
- Ventilation air should reach the breathing zone of the rooms as soon as possible after entering the room.
- Ventilation air should remove pollutants from the room effectively.
- Minimum ventilation rates should be increased when pollution loads are higher and can be lowered when pollution load is low

Air used for ventilation should be clean.

- Outdoor air used for ventilation should not contain harmful chemicals, particles or odours (as in EN 13779).
- Air-handling systems should not degrade the quality of the air supply.

Ventilation air should not cause harm.

- It should not cause unacceptable thermal discomfort due to its temperature, velocity or flow direction.
- It should not cause acoustic discomfort, adverse health effects or difficulties in oral communication, but it can be used to mask more disturbing or annoying sounds, such as telephone conversations in open office spaces. (An example of criteria for noise levels is given in EN 15251.)
- It should not cause damage to building structures or operation. A ventilation system may create pressure differences in building structures that may lead to unwanted draughts close to doorways, difficulty in operating doors and moisture transport to the structures. (For an example of limit values for pressure differences, see EN 13779.)
- It should not spread pollutants from structures, the ground, outdoor air or indoor sources. Ventilation should enhance the air in a building by making it flow from clean areas to less clean areas. Ventilation should remove pollutants from their source (local exhaust). Pressure differences created by ventilation should not significantly increase the entry of polluted soil or air into the building (radon and other harmful gases). Ventilation should not draw pollution from outdoor sources into the building (location of outdoor air intake). (Descriptive guidelines to avoid these problems are given in EN 13779.)

Ventilation should be provided to a building in an energy-efficient way.

- Air for ventilation should be moved in an energy-efficient way. Natural forces should be used as much as possible. The use of electricity for fans should be limited. A value of 2.5 kW per m³/s (including supply and exhaust air fans) is used in Scandinavian guidelines.
- Heat recovery from ventilation air should be encouraged. The energy density in exhaust air flow is high, and heat recovery is often an economical way of reducing the energy and operation costs of ventilation. Heat recovery becomes more feasible with high air flows and low outdoor temperatures. Limit values can be set for minimum efficiency of heat recovery and the size of the air-handling system when heat is to be recovered.

Ventilation should be controllable by the occupants.

Individual control of ventilation should be encouraged, as it improves user satisfaction. Thus, individual control should be provided if possible. Operable windows are one way to control ventilation and should be provided, particularly if the climatic conditions and location of the building are favourable for natural ventilation.

Quality control in design and construction

- The design of ventilation requires professional skills. Criteria can be set for the person responsible for the design, as in the United States (professional engineers) or Finland, where a building inspector checks the professional skills, training and experience of the principal designer.
- One criteria for the proper design of ventilation is documentation, which is needed during the construction and operation of a building. The requirement for documentation may include design calculations, drawings and technical specifications.
- Installation of ventilation requires professional skills. Criteria can be set for the person responsible for the installation, as in Finland, where a building inspector checks the professional skills, training and experience of the person in charge of the installation.
- Tests, measurements and inspections by building inspectors and others may improve the quality of an installation. Guidelines for commissioning have been drawn up by engineering associations in Europe (Federation of European Heating and Air-conditioning Associations) and in the United States (American Society of Heating Refrigerating and Air Conditioning Engineers).

Maintenance of ventilation systems

All ventilation systems require regular inspection and maintenance. An example of requirements is given in VDI 6022 (Verein Deutscher Ingenieure, 1997). Checklists for the hygienic operation and maintenance of air-conditioning systems are given in its appendix 3.1.

Table 2. Critical relative humidity for various groups of materials

Material group	Relative humidity (%)
Wood and wood-based materials	75–80
Paper on plasterboard	80–85
Mineral insulation materials	90–95
Extruded and expanded polystyrene	90–95
Concrete	90–95

Source: Johansson et al. (2005).

Table 3. Methods for controlling moisture for control of dust mites and microbial growth in new buildings with better building codes

Method	Effect on construction cost	Effect on energy consumption and cost
<i>Building construction</i>		
Improve thermal properties of windows.	Increase	Decrease
Design structures to resist the moisture loads of local climate and typical use of buildings (e.g. use vapour barriers).	Negligible	No effect or small decrease
Ventilate walls and other building components to prevent condensation.	Negligible	No effect or small decrease
Improve thermal insulation of building envelope to increase indoor surface temperatures to prevent condensation in cold and moderate climates.	Increase	Decrease
Prevent moisture migration from ground by draining surface waters.	Negligible	No effect or small decrease
Improve protection by roofing, walls and windows against rain.	Negligible	No effect or small decrease
Design and install material for minimum leakage of plumbing.	Negligible	No effect
<i>Ventilation</i>		
Provide openable windows in all living rooms and kitchen.	Slight increase	May increase or decrease
Provide adequate, controllable average ventilation.	Slight increase	May increase or decrease
Ventilate all rooms where needed.	Slight increase	May increase or decrease
Provide effective kitchen range hood.	Slight increase	May increase or decrease
Provide possibility for controlling ventilation on demand.	Slight increase	Decrease
Use mechanical exhaust ventilation in warm and moderate climates; tighten building envelope to prevent excess ventilation.	Slight increase	Decrease due to reduced air leakage
Use mechanical supply and exhaust ventilation with heat recovery to reduce relative humidity indoors.	Slight increase	Decrease
<i>Heating</i>		
Use central heating in cold and moderate climates.	Slight increase	Slight increase
Do not use unvented open-flame heaters.	No effect	No effect

Control indoor temperature with thermostats.	Slight increase	Decrease
Encourage use of district heating.	Negligible	Decreases use of primary energy
Require chimneys for all heating boilers and furnaces.	Slight increase	Better efficiency; decrease in primary energy
Improve control of fireplaces with e.g. dampers or shutters; to improve the thermal efficiency of fireplaces.	Slight increase	Decrease

Source: Seppänen (2004).

Table 4. Methods for controlling moisture in existing buildings

Method	Effect on construction cost	Effect on energy consumption
<i>Consumer behaviour and operation</i>		
Limit use of humidifiers.	No effect	Decrease
Do not dry laundry in living area.	No effect	Decrease
Use kitchen range hoods and ventilation during cooking.	No effect	Increase or decrease
Use ventilation and airing to prevent high indoor humidity and condensation.	No effect	Increase or decrease
Increase indoor temperature to decrease relative humidity.	No effect	Increase
<i>Refurbishment</i>		
Improve performance of ventilation (natural or mechanical).	Minor effect	Increase or decrease
Install mechanical ventilation system to improve ventilation (with or without heat recovery).	Medium	Decrease
Install double glazing to prevent condensation.	Medium	Decrease
Improve roofing to prevent water leakages, when applicable.	Medium	Decrease
Ventilate crawl spaces to prevent moisture migration from ground, when applicable.	Small increase	No effect
Install range hoods in kitchen.	Small increase	Increase or decrease
Replace unvented open-flame heaters and appliances with vented ones.	Small increase	Improves efficiency and reduces primary energy use

Source: Seppänen (2004).

Annex 2. National summaries on dampness and mould policies and/or regulations

WORLD HEALTH ORGANIZATION
REGIONAL OFFICE FOR EUROPE

WELTGESUNDHEITSORGANISATION
REGIONALBÜRO FÜR EUROPA



ORGANISATION MONDIALE DE LA SANTÉ
BUREAU RÉGIONAL DE L'EUROPE

ВСЕМИРНАЯ ОРГАНИЗАЦИЯ ЗДРАВООХРАНЕНИЯ
ЕВРОПЕЙСКОЕ РЕГИОНАЛЬНОЕ БЮРО

WHO expert meeting on policy recommendations on interventions and actions against dampness and mould

Bonn, Germany, 9 - 10 February 2009

National summaries on dampness and mould policies and/or regulations

Contents

Belgium.....	96
Denmark	99
England, Scotland and Wales	102
Finland.....	104
France.....	106
Germany	108
Lithuania.....	109
Luxembourg	110
Netherlands	111
Slovakia	112
Spain.....	114
Sweden	116

Belgium (*Catherine Bouland*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

The answer to this question covers private homes and schools, day-care centres and nurseries.

Private homes

Interventions related to a health diagnosis done by a medical doctor:

The *Green Ambulances* in Brussels–Capital Region and the provinces of the Walloon Region do an environmental diagnosis that complements the medical diagnosis performed by a medical professional. The environmental diagnosis can be either extensive or specific to the health problems and includes a search for dampness and mould. When mould is identified, the service advises on how to eliminate it. During the diagnosis process, a further search for sources is done, but it does not always provide information on building aspects of the problem.

In the Flemish Region, the Division of Public Health Surveillance of the Flemish Agency for Care and Health implements the assignment of the Green Ambulances.

Interventions related to preventing sickness due to indoor pollution:

In the Flemish Region, the Division of Public Health Surveillance of the Flemish Agency for Care and Health can inspect houses and public buildings, such as schools, day-care centres and nurseries, and call for laboratory identification of mould. This process is related to a decree from 2004 on health prevention and indoor pollution with qualitative and quantitative recommendations; and adds to the Flemish Housing Code that dates from 1997. A demand for an enquiry can be filled by public authorities (local and regional) or by medical doctors (with the authorization of the resident) belonging to a local network of health professionals called LOGO. If an intervention is required, the Division of Public Health Surveillance performs the inspection in compliance with the recommended thresholds cited within the decree from 2004.

Interventions related to building security, stability and unhealthy housing on the basis of the regional housing code:

The inspection is based on the different levels of requirements of the regional housing codes. The regional housing codes are founded on the article of the Belgian constitution that also relates the right to decent housing. The codes for the three main regions are as follows.

- The Flemish Housing Code dates from 1997 and was completed by the Indoor Environment Decree of 2004.
- The Walloon Housing Code dates from 1998. It has been modified, and the modification done in 2004 includes indoor pollution as an objective for inspection. When applying the Code, a legal decision of the Walloon Government in 2007 sets out the minimal criteria for indoor pollution.
- The Brussels Region Housing Code is more recent and dates from 2004. It integrates mainly security and stability aspects of housing and includes mould and dampness in unhealthy situations. The approach it takes, however, is still very theoretical.

In the three regions, inspections are performed so that they conform to the recommendations written in their respective code. The codes focus on rented housing, and the objective is to decide

if such housing does or does not conform to the recommendations in the code. When housing is declared not to conform, the owner has a reprieve to implement the mitigation work and eventually receive a certificate that allows the housing to be rented.

Schools, day-care centres and nurseries

Programmes that support indoor pollution prevention:

The Green Ambulances of Hainaut Province and of the Brussels–Capital Region have developed a monitoring programme for nurseries and day-care centres, to prevent or mitigate the occurrence of indoor pollution. The programme includes dampness and mould (search and identify) and provides advice for ameliorating the occurrences of pollution observed. It is based on a voluntary approach and has the support of the Children Programmes (Office National de l’Enfance) that licenses nurseries and day care-centres in the French community. More recently, a national programme (2007–2008) was performed within the framework of the Belgian National Environmental and Health Action Plan. It covered day-care centres from all over Belgium and developed a self-check list, a toolbox and advice for preventing indoor pollution.

Inspections are made by School Inspection to verify *conformity with recommendations* by the French, the Flemish and the German communities. They verify conformity to prevent an unhealthy situation, but dampness and mould is not the unique focus of these inspections. When mould is observed, the services of the Mycology Department of the Belgium Scientific Institute of Public Health help identify it and give specific advice on how to remove it.

Interventions that prevent sickness due to indoor pollution:

In the Flemish Region, the Division of Public Health Surveillance of the Flemish Agency for Care and Health can inspect public buildings, such as schools, day care-centres and nurseries, and call for laboratory identification of mould. This process is related to a decree from 2004 on health prevention and indoor pollution with qualitative and quantitative recommendations. A demand for enquiry can be filed by public authorities (local and regional), medical doctors working with LOGO. If an intervention is required, the Division of Public Health Surveillance performs the inspection to verify compliance with the recommended thresholds cited within the decree.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor’s work?

Depending on the intervention scheme, there is or is not monitoring of the mitigation and renovation work.

Green Ambulance scheme:

The monitoring of this scheme focuses on health improvement; often such improvement is a consequence of good mitigation work.

Housing inspection:

When a dwelling is declared to not comply with the regional housing code, owners are requested to do the necessary mitigation and renovation work, within a defined time (eight months in the Brussels–Capital Region, for example). After the period of reprieve expires, inspectors verify the conformity of the work; otherwise, the dwelling is declared not suitable for rental.

Health inspection in the Flemish Region:

If the mitigation work does not satisfy the health objectives, a report is sent to the authorities, who can then decide to close the building.

Health inspection for schools, day-care centres and nurseries:

If the mitigation work does not satisfy the health objectives, a report is sent to the authorities, who can then decide to close the building.

No support is given to residents to assure the quality of the contractor's work. Information campaigns provide information on results, such as health objectives, ventilation, and fact sheets on various aspects linked to building renovation.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

In Belgium, the multiplicity of the levels of action and the number of actors create confusion, so harmonization of efforts would be the first step. Otherwise, the priorities are: guidance; training inspectors on adverse effects on health, to better identify risks; education and licensing of contractors and craftsmen; and information campaigns focused on best practices. Enhanced communication among the various actors is also required.

Denmark *(Anne Pia Koch)*

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

In Denmark, when new houses are being built, the local municipality has the right (but not the duty) to inspect the building site. After a new house is finished, the parties meet one year after and 5 years after, at which time all claims can be raised and discussed and remedial actions planned.

When houses are sold, there is a legal requirement that the seller commissions an approved inspector to inspect the house and write a report on its condition. This report should include comments on such problems as construction, maintenance, moisture and mould. These consultants must be registered with a control scheme, which is currently administered by the Danish Technological Institute. Privately owned houses are not covered by any other official and/or public inspection scheme. Mould and moisture renovation – for example, for water damage caused by leaks or firefighting or defects identified in connection with the purchase/sale of a property – is the owner's expense, unless it is covered by insurance.

In the case of moisture and mould in buildings with flats for rent, tenants can ask the local municipality (commune) to inspect a house or building. They have an obligation to act on a claim from one or more occupants. The municipality carries out inspections according to the Law on Building Renewal, §75; the Law of Building, §16; and the Ordinary Law for Housing, §§ 164 and 169. It covers all houses and flats and generally all residential places that are inhabited.

Some communes have a special housing commission that can act on this. In most cases, they will call for special surveyors to investigate the house. The results are classified into three categories.

1. **An obvious threat to health and safety.** This may lead to an obligation to prohibit occupation of the flat and a demand for remediation.
2. **No obvious threat to health and safety.** This gives rise to the possibility of giving recommendations.
3. **Minor mould attacks that may or may not present any risk to health and safety.** In this case, no recommendations are given. This gives rise to the possibility of giving recommendations or asking for an investigation.

Cases 1 and 2 may lead to a decision that the flats are not suitable for occupation. Then the house owner is given appropriate notice and will be required to carry out remediation. Following this, the house owner can apply for financial support for renovation or demolition of the building.

In rare cases – and only upon request from the municipality – buildings are inspected by a regional officer (national medical consultant) from the Danish National Board of Health. These may be cases where, for example, a number of tenants have reported symptoms that could be caused by problems with the indoor air quality.

Schools and institutions are responsible for the general maintenance of their buildings. But the municipality is responsible for the main renovation projects and for the soundness of the buildings. If employees report any health problems to the health and safety authority (Danish

Working Environment Authority), the authority can carry out inspections and interviews and request support from experts within the field.

Children are not protected in their working environment (schools or day-care institutions) by this authority. But the regional officer (national medical consultant) from the Danish National Board of Health – where, for example, more tenants have reported symptoms that could be caused by problems with the indoor air quality – can be involved in the case.

The validity of the surveys carried out depends on the quality of the surveyor. There is no guarantee.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

Renovation work is carried out by private contractors that, in the best cases, are skilled and work in collaboration with experienced and skilled consultancy firms. In the worst cases, the contractors do not have any experience and knowledge about either moisture or mould growth in buildings. Also, not all consultants have the necessary competence, and there is no licensed and no public agency. The Danish Technological Institute is impartial and supported by the government, but is not publicly owned.

Private residents receive no support to assure the quality of a contractor's work, unless they pay for such control themselves. And since there is no licensed and/or public agency, the private resident has no help in finding a good qualified surveyor.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

Denmark's new Building Regulation BR09 focuses on dampness and mould, and guidelines on how to implement BR09 in practice are being prepared. A new guideline on how to prevent moisture in buildings is expected to be published later this year.

The governmental measures to save energy in existing buildings – focusing on building envelope tightness, insulation and heating – may lead to increased problems with dampness and mould. Earlier insulation initiatives have led to dramatic mould growth in exterior wall constructions, floor constructions and in roof spaces. Full experience from these mistakes and implementation of the knowledge gained from them in practical guidelines for new insulation initiatives are both lacking. Also, a special consultancy board or group of consultants for energy saving initiatives focuses little on the issues of dampness and mould.

All homes with a newborn baby are visited by a public nurse. These nurses should have a mandate and a training course in the behavioral problems caused by dampness and mould, so that they can advise a family about such preventive measures as cleaning, ventilation and reduction of moisture. The problems caused by mould may be acute when babies are found with eczema, asthma, allergy or other related symptoms.

If the occupant of a rented flat claims that there is dampness and mould in the flat, the rules and the mandates to handle the problems are there; however, the qualified staff and/or the money to pay for qualified building surveys is often lacking, and it takes too long for the problems to be resolved by the system. There is a lot of focus on this situation, and it has improved, but it does

not work equally well in all cases. The creation of a central and highly skilled public advisory team, giving free telephone and information-technology-based support, could help a lot.

Also, education and licensing of craftsmen doing moisture and mould remediation could be very effective in ensuring that the remediation is adequate and effective. Moreover, education and licensing of building surveyors that can carry out qualified moisture and mould investigations and quality control could also be effective.

England, Scotland and Wales *(David Kelly, David Ormandy)*

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Dwellings (public or private)

The duty to identify or inspect dampness and mould in dwellings is mandated as follows.

- The duty on local housing authorities to review housing conditions in their district (Section 3 of Housing Act 2004) can involve inspections at the local authority's own volition. Also, regular surveys (national and local in England, Scotland and Wales) are carried out after a House Condition Survey procedure, which assesses the condition of the housing stock against a number of factors. The surveys use the Housing Health and Safety Rating System (HHSRS) to categorize hazards that include condensation and/or mould issues. Analysis of the data informs policies and priorities.
- The duty on local housing authorities to respond to complaints and to investigate if they suspect or have information about unsatisfactory housing conditions (Section 4 of Housing Act 2004) means they must respond to a complaint (from a tenant) or enquiry (from an owner-occupier).
- Under Part 1 of Housing Act 2004, dwellings must be assessed using the HHSRS. Dampness and mould is one of the 29 *hazards* under the HHSRS. Where a hazard is assessed as unacceptable, the local housing authority is under a duty to take action to require the hazard to be eliminated or mitigated (section 5 of Housing Act 2004); and it has powers to require elimination or mitigation where the hazard, although not unacceptable, could be eliminated or mitigated.

Data for the last year show that, based on the HHSRS, action has been taken in 10 054 dwellings (data are from only 40% of all English local housing authorities, so the overall figures will be 20 000 dwellings and more). It can be assumed that for the rating exercise, local housing authorities will target those properties suspected of being unsatisfactory. Also, there would have been dwellings that were assessed as satisfactory. In addition, there is also a government target for all public (social) housing that states that it must be free of any unacceptable hazard by 2010.

- The 2006 Housing Act of Scotland gives power to Scottish ministers to adapt and implement the *tolerable standard* for housing. Local authorities must use this standard when identifying whether or not a dwelling is inhabitable due to possible adverse effects on health arising from condensation or mould (and other factors). Where a dwelling is identified as below tolerable standards, it cannot be rented, let or occupied until the landlord or owner has carried out sufficient work to remediate the problem.

Schools

The duty to identify or inspect dampness and mould in schools is mandated as follows.

- The Health and Safety at Work Act from 1974 places duties on employers to protect the health, safety, and welfare of employees and the general public. This duty is enforced by the

Health and Safety Executive (a national agency). The Health and Safety Executive can respond to a complaint or act on other information.

- Local authorities are under a duty to investigate premises where they suspect those premises are in a state “prejudicial to health” under Part III of Environmental Protection Act 1990. Where the authority is satisfied that premises are prejudicial to health, they must take action to ensure the threat is removed.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor’s work?

Dwellings

The follow-up and monitoring of mitigation and renovation work in dwellings are as follows.

- The options for action under Part 1 of Housing Act 2004 are: issue a notice that requires specified remedial work, giving a date for completion; or issue an order that prohibits the dwelling’s use for human habitation. It is a criminal offence not to comply with the requirements of the notice or order.
- The local authority can revoke the notice or order when it is satisfied that the work has been completed properly.
- The 2006 Housing Act of Scotland requires local authorities to close, demolish or improve houses that do not meet the tolerable standard. Assessors from the authority, independent of the departments carrying out remedial work, assess the competence and effectiveness of the work undertaken.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

No additional regulations or legislation are necessary. However, because of the scale of the problem in England and Wales, additional resources (personnel and financial) would mean the problem could be dealt with quicker.

Finland (*Matti Jantunen, Jarek Kurnitski*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Tenants of day-care centres – or anyone responsible for a public building – can just call a municipal inspector, if mould or moisture problems are suspected. There is no payment for the first visit of the inspector. The inspector will decide which inspections and measurements are needed. In private buildings, the building owner will pay the cost of possible measurements or further inspections. If the situation is a threat to health, the inspector has the right to ban the use of the building. The inspection procedure is very case dependent when an inspector suspects a mould or moisture problem. Commonly, visual inspection and non-destructive and destructive methods combined with moisture, mould and ventilation measurements are used.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

No, there is no such system in Finland. This issue, however, is covered by informative guidelines; but it is still rather complicated in practice, as the common practice is limited to controlling the quality of the construction work specified.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

Regulations are needed for both the design and construction of new buildings and for inspection and repairs of existing buildings. Also, informative guidelines and education on management options are needed.

Regulations for the design and construction of *new buildings* should cover the following areas.

- The building code (or other regulatory decree) that deals with moisture and mould control and prevention in the buildings should regulate this area.
- This regulation should specify requirements for design, as well as inspection and permission of the construction, that can be seen as preventive measures – that is, if followed, then buildings are designed and constructed so that water leaks, moisture condensation and seepage (and the consequent mould problems) are effectively avoided.

Regulations for *existing buildings* – to be applied in the documentation, maintenance, inspection and assessment of the buildings, and evaluation of the repair options, when necessary – should define:

- indicators of mould and moisture problems – that is, the cases for which an inspection of mould and moisture problems is needed;
- criteria for identifying the presence of a health hazard and respective repair need – that is, which outcome of inspection or measurements is interpreted as a health hazard and needs repair measures); and
- general criteria for the content of repairs (such as replacement of contaminated materials and removal of the original cause) and verification of their success (observations, measurements,

necessity and timing of the post-repair inspections – that is, how to check that repairs have been successful and problems have been solved).

Informative guidelines and *educational and training materials* are needed for design solutions, repairs, inspections and measurements. These will explain: the mechanisms and processes, causes, and consequences of moisture damage and mould growth in the buildings; justification for the guidelines and regulations; and best practice examples for design solutions and implementation, both in new and existing buildings.

France *(Corinne Drougard)*

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Private homes

When tenants complain about their dwelling to local authorities or the local government, an environmental health officer is sent to the dwelling for inspection. Public intervention in dwellings where residents are exposed to health risks is framed by specific conditions. "Public intervention" refers to the direct power used by public authorities, namely mayors and prefects, to impose on owners the renovation (or demolition) of buildings when their condition is such that public health or safety issues are raised. Public intervention is based on local health regulation or on the Public health code, according to the seriousness of the situation.

Health officers have at their disposal a questionnaire to help them evaluating the quality of the dwelling. Among the criteria of this grid, one addresses dampness and mould.

Dampness and mould are among the main reasons of complaints.

After the inspection, the owner/landlord will be urged to carry out adequate renovation measures. If these are not implemented, owners will be forced to make them by an administrative act.

Schools

There is no specific inspection program for and mould in schools. At the region level, an inspector deals with safety and security in schools. The inspector has to inspect the schools, and can prescribe renovation actions when it is considered necessary.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

ANAH (L'Agence nationale de l'habitat – National Housing Agency) is a national public institution created to help private owners to fund rehabilitation of their dwellings when these works fall within the priorities defined by the Agency.

The ANAH is administered by a council that includes State representatives (Ministry of Housing, Ministry of Finances, Ministry of Health), local authorities and representatives of owners, tenants, professionals, and qualified personalities. The Agency's intervention budget is attributed annually by the State.

In each department, an ANAH delegation is active in managing and instructing subsidy request dossiers.

The ANAH has two principal types of "clients":

- private owners and landlords;
- owner-occupiers with specific income conditions

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

No additional regulations/legislation is necessary. However, information campaigns are needed for the public as well as for relevant housing specialists. Education materials should be developed for the occupiers to deal with dampness and mould (a French information brochure about technical solutions to remediate dampness and moulds, and with key messages, has been developed). It is also important to inform the building professionals like craftsmen but also architects about the importance of balanced approaches towards ventilation and thermal insulation.

Germany (*Regine Szewzyk, Marle Kopf, Bernhard Link*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Mould is inspected by public agencies mainly in public buildings with health complaints. In some of the federal states, mould is also inspected in private homes in cases where tenants file complaints.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

There is no systematic follow-up of remediation measures on a national level, but there are a few activities in the federal states within the scope of local projects. Also, there are several education programmes on mould and dampness for craftsmen and inspectors. Harmonizing these different programmes is a task for the future, to better allow the consumer to judge the skills of the contractors.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

When problems with mould are discovered in an apartment, there are often long-lasting conflicts between the parties involved (landlord and tenant) on who caused the problem. Many cases are even brought to court. From a health perspective, this is undesirable, since exposure to mould may continue for months and years. Therefore, solutions must be found to solve the problems before the conflict escalates, to enable fast action against mould and dampness. For this, we need an interdisciplinary approach on the local level that also includes information about vulnerable groups and harmonized education (certification) of craftsmen and inspectors. In this context, operational definitions for dampness and mould interventions are needed.

Lithuania (*Ingrida Zurlyté*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Dampness and mould will be identified as a problem in private homes if inhabitants complain to public institutions on a specific dampness- and/or mould-related problem. Usually, complaints go to local public health care institutions or municipalities.

For newly built housing, a problem might be identified during the acceptance procedure (a building has to be accepted as suitable for use), but this is only related to dampness (indirectly) when checking the operation of a ventilation system.

Public health care institutions on regional and local levels are responsible for controlling public health safety in schools. All schools have to be visited annually (inspection rate 100%). Dampness and mould problems can be identified during inspection or through a complaint from the head of a school. Temperature, relative humidity and air movement can be directly measured by an inspector, to check compliance with hygiene. Mould is not part of the regulations on hygiene, but it can be measured by the National Public Health Care Laboratory.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

There is no monitoring mechanism for mitigation and renovation work. Private residents, however, can approach consumer protection institutions in case of dissatisfaction with the quality of the work.

For disinfection activities, licensing is required. For these activities, the overall mechanism for control of public health care activities subject to licensing is applicable.

Other related procedures involve the authorization and registration of biocides relevant to mould issues (for wood and brick surface). Biocidal products can be for professional and general use. The State Labor Inspectorate of the Republic of Lithuania is responsible for the proper use of biocides in the work environment.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

First, it is important to give due attention to construction features, ventilation, and construction and/or renovation technologies. Second, there is a need for clearer, specific mention of mould problems as a consequence of, for example, different types of misuse, improper treatment and applications. Third, information campaigns are needed for the public, as well as for relevant specialists. Last, regular surveys would help to reveal the extent of a problem and to monitor progress.

Luxembourg *(Ralph Baden)*

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

When:

The official structures that inspect mould and dampness problems are the Service of Environmental Medicine for private homes and schools, as well as the Department for Occupational Health for schools. Both structures are within the Ministry of Health.

For private homes, a prescription from a physician is needed, to make sure of the health-related origin of the application. For schools, a simple request by the responsible authority (such as the director of the school, superintendent of primary schools or Ministry of Education) is sufficient.

How:

Specialists will take samples (both from the air and from surfaces), for incubation and determination of air contamination, as well as measure humidity (inside and at the surface of contaminated materials) and surface temperatures, to identify the cause of a patient's illness. Patients receive a detailed report with all the information about contamination, sources and short- and mid-term measures to take (a copy of the report goes to the physician).

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

Occupants of private homes (owners or tenants) and local authorities in the case of schools receive a detailed report containing quantification of mould exposure, possible effects on health, results of humidity and surface temperature measurements, identification of causes of dampness and advice on short- and mid-term remediation. A systematic follow-up or monitoring is not planned, but can be arranged if the people concerned ask for it. No support is foreseen either for private residents or schools.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

More than 50% of the mould problems in Luxembourg are due to condensation in combination with thermal bridges. Obviously, these occur during construction or renovation. Therefore, information and the education of building professionals – such as craftsmen and architects – are strongly needed.

Special legislation, such as the German legislation about decreasing rent, would strongly encourage owners to fix mould problems when tenants are concerned.

Netherlands (*Piet van Luijk*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Mould is inspected and identified only after complaints by residents, mostly tenants. The assessment method is visual inspection, and the diagnosis of an adverse effect on health is based on location and surface area of mould.

Complaints are filed by the owner or user at the municipal Public Health Department or at the offices of the building supervisor of the local municipality. There is no active surveillance or monitoring of mould problems in the Netherlands. At regular times, questionnaires are sent out to monitor the quality of the housing stock. These questionnaires include some questions about visible mould growth.

Sampling and laboratory assessment is quite rare, but professional services and certified sampling methods are available.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

There is no follow-up, except in rare cases that are monitored by consumer organizations or health institutions (Public Health Services).

For extensive renovation of buildings, a licence is needed from the local municipality. In this case the Building Decree has to be complied with, and also the building supervisor of this municipality might supervise the work done, especially to see if it is in accordance with the licence (performance criteria of the Building Decree).

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

The Building Decree and rent law are satisfactory regulations. The present legal situation provides good protection against exposure to mould in buildings. Tenants may receive a rent increase when their complaint to their landlord about mould and remediation is ineffective.

Information about mould and its adverse effect on health is available, but the perception of risk among occupants and landlords is relatively low: to start remediation, complaints must be expressed. Information campaigns about proper ventilation were held during the period 2003–2006.

The overall occurrence of mould in the building stock is monitored, but remediation depends on local procedures for handling complaints. From the perspective of health complaints, it would help significantly if there was a way to measure whether a situation is unhealthy or not – be it measuring mould, spores or volatile substances coming from it or even the size and place of the mould growth – and if there was (inter)national agreement on this. Performance testing of laboratories that sample and analyse mould species, guidelines on concentration of mould fragments (spores and mould material), and exposure levels are unavailable currently.

Slovakia (*Katarina Slotova*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Mould contamination of schools is controlled by two policy approaches:

- the Act of the National Council of the Slovak Republic No. 355/2007 on protection, support and development of public health (National Council of the Slovak Republic, 2007); and
- the Decree of the Ministry of Health of the Slovak Republic No. 259/2008 Coll. on details on requirements for interior of buildings and on minimum requirements for apartments of lower standard and for accommodation facilities (2008).

The state policy on health includes: target values for indoor air quality and/or indoor air pollution, and microclimate (temperature and humidity) requirements for heating, ventilation, insulation and air-conditioning. The presence of condensation on surfaces or in structures and visible mould in indoor environment are forbidden.

The state policy on health delineates the rights and obligations of authorities of state administrations, communities, other legal entities and people. It also delineates the actions of the state administration and the state health inspectorate in charge of the section on protection of human health. Among the general obligations of this policy is that health must be also protected through care of indoor spaces in the living environment and other non-industrial buildings and places accessible to the public. The policy does not delineate the rights and obligations of private people with regard to indoor air.

Authorities in charge of implementing the policy are public health authorities on the regional level in Slovakia. Regional public health authorities perform state health supervision of schools, prepare supporting material for measures and decisions of authorities on health protection, and perform specialized tasks connected with health protection in the branch of hygiene of the living environment, including moisture regulations and health education.

Regional public health authorities supervise the fulfilment of regulations of this health policy and supervise commonly binding legal regulations.

Through inspection, when visible dampness or mould occurs in schools, a regional hygienist prepares a decision for the building owner to carry out, such as appropriate remedial measures that should remove or minimize the problem.

Owners of private houses are responsible for their own house, but the public health services carry out visual health inspections of dwellings in rented houses. This is based on self-reported problems or complaints of dwelling occupants. The public health services prepare for dwelling occupants a short statement that contains recommendations for appropriate technical remediative action; this is done with the cooperation of the owner(s) of the house and of the construction authorities. In some regions, visual inspection can be completed by microbiological identification of mould and measurements of mould concentrations in indoor air.

Also, occupants are educated to manage water use, heating, ventilation and appliances in a manner that does not lead to dampness and the growth of mould.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

No. There is no such agency in Slovakia, and no regular support is given to private residents in assuring the quality a contractor's work.

In the field of microclimate, professional qualification can be acquired at the Ministry of Health. Professionals can be licensed to do this work but show no interest in doing so.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

Relevant actions or regulations that improve the national situation on preventing dampness and mould or mitigating their occurrence include:

1. better building codes for moisture control (to improve the responsibilities of municipal councils and/or authorities for construction) and extended municipal mandates;
2. better building codes to improve the responsibilities of and building stock surveyors;
3. education and information campaigns for technical specialists and for the general public; and
4. guidelines:
 - on how to control moisture in buildings, to avoid mould-related problems;
 - for the public on how to check and control the indoor environment of their home;
 - for ventilation (residential and non-residential building);
 - for the operation and maintenance of buildings; and
 - for heating and cooking, to avoid moisture problems – for example, to establish a target value of 17 °C as the minimum temperature at the thermostat on space heaters, radiators and heating control devices in living spaces, to prevent turning off their heating to save energy.

Spain (*Maria José Carroquino Saltó*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

Homes:

Local authorities (city governments) have the legal competence to inspect dwellings and act as needed in case there is a threat to health or safety within the private homes or to the neighboring homes.

When new private homes are built, whether they are single-family homes or apartment buildings, the building goes through a rigorous process of inspections aimed at providing a “certification” which is needed at each phase of the construction process. The certification process is a well-defined process following the Technical Building Code, a legally mandated norm to be followed, where building materials, ventilation requirements, and all other construction-related matters are specified. Once the building is finished, it must receive the “Habitability Warrant”. The Habitability Warrant is provided by the local authority following an inspection from an architect or other similar professional qualified to verify the habitability of the dwelling. This warrant must be renewed periodically (in some regions every 15 years) and is a prerequisite for being able to contract minimum services of electricity, water and gas.

For newly built housing, a problem caused by malfunctioning of some installations might only be identified once the home has been acquired by the buying party. In this case a claim is usually made to the construction company (often causing problems, as many construction companies dissolve once the construction work has finished).

When old homes are rehabilitated extensively, they must receive the necessary permits by the city government to undertake the necessary work. The Technical Building Code also has to be followed, and a supervisor of the municipality may inspect the work at each step to see if it is in accordance with the permits.

In privately owned homes, dampness and mould are identified only after complaints by residents, either owner or tenants. The tenant communicates the humidity or mould problem to the owner, who is responsible for making the necessary repairs (although he/she may claim the repair to the own insurance company (if the insurance policy covers such repair) or to the insurance company of the home or apartment causing the humidity (in case of apartment buildings). When there is good will, this is usually smoothly resolved.

Inspections by public agencies are not done unless the dispute turns into a court case; then a technical inspection for backing up the claim may be required.

The greatest problems arise with substandard housing. These homes are usually occupied or owned by very poor people who cannot afford a proper insurance of the home or the necessary repair work. Inspections of such homes are not done until a claim by neighbours reaches the court, in which case a technical inspection may be done and the homes may be evacuated due to safety and health risks.

Schools:

For schools, the education-related competencies are at the regional level, but the safety and integrity of buildings and infrastructure is sometimes with the local level. However, there are no routine inspections carried out by public agencies and the schools have to identify potential problems independently. The schools have a maintenance budget that they may use for minor repairs, but when major works are needed, the school may call the respective competent authority (education, infrastructure, housing, etc. at regional or local level) that will put in place

the mechanisms to solve the problem. However, this often leads to long-term problems with e.g. humidity which are not solved because of lack of funding within the annual budget or different priorities (i.e. building a new school).

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

There is no follow up or monitoring mechanism for mitigation and renovation work once the renovation is finished. The legislation requires that the contractors have sufficient skills and that they control their own work. Controversial cases are handled through insurance companies or in court.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

When problems with mould are discovered in an apartment, and a conflict develops between affected parties (landlord and tenant; or conflicts between owners/residents of neighboring dwellings/homes), any of the parties should be able to call public authorities to intervene in order to avoid the persistence or increase of mould during the time of the conflict.

Some regulations with respect to substandard housing should be developed. For example, the habitability warrant should only be granted for 15 years if housing conditions allow predicting that they will provide a safe living environment during the time indicated. A system of inspections should be developed for substandard housing, specially allowing the "closure" of uninhabitable dwellings until they are rehabilitated. The competent authorities should be able to act consequently on those homes that are not in possession of the habitability warrant (possibly to dismantle them) and evacuate the tenants or owners.

Sweden (*Greta Smedje*)

How and when (in what situations) do official or public agencies identify and/or inspect dampness and mould in private homes and schools?

For **homes**, local authorities are obliged to have inspectors that supervise the fulfillment of national legislation on healthy dwellings. Usually inspectors respond after being contacted or after receiving complaints from individual occupants. They may inspect the home and demand preventive measures or further investigations from the owner. Usually the homes of private individual are not inspected. For 2010, the National Board for Health and Welfare is planning a special campaign on healthy indoor environment in homes, but the details are yet to be decided.

For **schools** and other public premises, the obligation of the local authorities includes supervision of the indoor environment. For schools and day-care institutions, local authorities often have programmes, including inspection of such institutions regularly.

As a part of the health care system, some hospitals have employees (usually nurses) who may inspect homes of individual patients, if there is a suspicion that poor housing conditions contribute to their illness. Furthermore, departments of occupational and environmental medicine may also inspect and investigate indoor environments in both homes and schools.

Does a public (or licensed) agency follow up or monitor mitigation and renovation work? Is any support given to private residents in assuring the quality of a contractor's work?

No and no. Legislation specifies that the contractors have sufficient skills and that they control their own work. Controversies are handled through insurance companies or in court.

What would be – from a health perspective – a relevant action or regulation to improve the national situation on preventing and mitigating dampness and mould?

Swedish legislation, nowadays, relies on general demands on function, rather than details on how to solve a certain problem. Furthermore, industry or others performing a task are obliged to control their own quality of work, rather than relying on public inspections. This development may have gone a bit too far. The quality of work is too often insufficient. Without reducing the responsibility of contractors, public supervision and control needs to be strengthened and increased. Improved education and licensing of craftsmen are also needed, both within the regular education system and within their own societies. Their education must include an increased awareness that these problems are real and important.

Annex 3. List of participants

Temporary advisers

Ralph Baden Department of Occupational Health Ministry of Health Luxembourg	Luxembourg
François Belanger Institut de Veille Sanitaire	France
Catherine Bouland Health and Indoor Pollution Brussels Institute for the Management of the Environment (IBGE-BIM)	Belgium
Maria José Carroquino Saltó Instituto de Salud Carlos III WHO Collaborating Center for Epidemiology of Environment Related Diseases	Spain
Michael Davies Bartlett School of Graduate Studies Faculty of the Built Environment University College of London	United Kingdom
Corinne Drougard Ministère de la Santé	France
Nathalie Duclovel-Pame French Agency for Environmental and Occupational Health Safety	France
Christian Farrar-Hockley Health and Environment Alliance	Belgium
Evert Hasselaar OTB Research Institute Delft University of Technology	Netherlands
Matti Jantunen Department of Environmental Health National Institute of Health and Welfare	Finland

David Kelly Scottish Enterprise Technology Park Building Research Establishment	United Kingdom
Anne Pia Koch Danish Technological Institute	Denmark
Laura Kolb Indoor Environments Division United States Environmental Protection Agency	United States of America
Iris Kompauer State Health Office Baden-Württemberg WHO Collaborating Centre for Housing and Health	Germany
Marle Kopf Verbraucherzentrale NRW, Umweltberatung	Germany
Jarek Kurnitski HVAC-Laboratory Helsinki University of Technology	Finland
Bernhard Link State Health Office Baden-Württemberg WHO Collaborating Centre for Housing and Health	Germany
Lars Molhave University of Aarhus	Denmark
David Ormandy School of Law University of Warwick WHO Collaborating Centre for Housing Standards and Health	United Kingdom
Rémi Poirier French Agency for Environmental and Occupational Health Safety	France
Katarina Slotova Regional Authority of Public Health	Slovakia
Greta Smedje Department of Occupational and Environmental Medicine Uppsala University Hospital	Sweden

Diana G. Smith Health and Environment Alliance	France
Regine Szewzyk Section II 1.4 (Microbiology, Parasitology) Federal Environment Agency	Germany
Piet van Luijk Ministry of Housing, Spatial Planning and the Environment	Netherlands
Claudia Weigert Environmental Health Division Directorate General of Health	Portugal
Ingrida Zurlyté State Environmental Health Center	Lithuania

World Health Organization

Regional Office for Europe

Matthias Braubach
Technical Officer

Michal Krzyzanowski
Regional Advisor

Nathalie Röbbel
Consultant

Secretariat

Andrea Rhein
Programme Assistant

Intern

Jonas Savelsberg

Annex 4. Abbreviations

ENHIS	European Environment and Health Information System
EU	European Union
EPA	United States Environmental Protection Agency
HEAL	Health and Environment Alliance
HHSRS	Housing Health and Safety Rating System
HUD	United States Department of Housing and Urban Development
IOM	Institute of Medicine
OHHLHC	United States Department of Housing and Urban Development Office of Healthy Homes and Lead Hazard Control
PATH	Partnership for Advancing Technology in Housing
PD&R	United States Department of Housing and Urban Development Office of Policy Development and Research
PIH	United States Department of Housing and Urban Development Office of Public and Indian Housing
PINCHE	Policy Interpretation Network on Children's Health and Environment
PRONET	Pollution Reduction Options NETWORK
RHINE	Respiratory Health in Northern Europe study

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ABSTRACT

The presence of dampness or biological agents such as mould in indoor air or building structures is largely attributable to occupant behaviour, building characteristics and, in particular, to condensation, inadequate ventilation and structural failures. Although the presence of dampness and mould has been confirmed as a health threat, the health sector has responded to this challenge with little action. In part, this lack of action is due to the lack of guidance and recommendations on actions against dampness and mould.

To provide recommendations on policy actions and frameworks that support interventions against dampness and mould, WHO reviewed technical interventions as well as national policies and regulations to discuss the best mechanisms for the protection of public health and the reduction or mitigation of exposure to dampness and mould problems in indoor settings.

This WHO report consists of the two expert meeting reports that were held in the context of this project. The first meeting report summarizes the review of technical actions and interventions against dampness and mould which were provided as case studies from a variety of countries. It provides a range of recommendations on good technical practices to prevent, reduce or remove dampness and mould.

The second meeting report provides policy-related recommendations and identifies potential ways for international, national and local authorities to prevent, reduce or mitigate exposure to dampness and mould. It will enable policy-makers to identify appropriate measures to support and advocate in the field of public health protection and will provide them with relevant examples and guidance for policy and regulatory measures.

This report complements the WHO indoor air quality guidelines: dampness and mould with recommendations on actions for achieving conditions recommended by the WHO guidelines.

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World Health Organization Regional Office for Europe

Scherfigsvej 8, DK-2100 Copenhagen Ø, Denmark

Tel.: +45 39 17 17 17. Fax: +45 39 17 18 18. E-mail: postmaster@euro.who.int

Web site: www.euro.who.int