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LANDESGESUNDHEITSAMT BADEN-WÜRTTEMBERG
IM REGIERUNGSPRÄSIDIUM STUTTGART

Newsletter

WHO Collaborating Centre for Housing and Health
Baden-Württemberg State Health Office

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Editorial

Retrospect

With this issue, you are holding the 20th newsletter of the WHO Collaborating Centre for Housing and Health in your hands or you are seeing it on the screen. Additionally, this is the last newsletter within our current designation period as a WHO CC, which comes to an end during September. This has been the motivation for us as an editor of this newsletter to look back on the last 8 years in which we published our newsletter.

As a key concern of our newsletter, we wanted and still want to strengthen the interdisciplinary cooperation in the housing and health issue and bring the various actors in this field closer together. When I look back at the range of topics we covered within our contributions, I think we met our requirements. For example, besides contributions to indoor air pollutants such as mould or radon, there were also articles on noise, heat waves, children's accidents and housing for the elderly, and the authors represented different disciplines, too. At this point, I would like to especially thank all authors, who supported our concern with their contributions.

If we get the green light by the WHO for a further designation period as a WHO CC, we intend to continue the regular publishing of this newsletter on housing and health during the next four years. As a change, however, we intend to publish 4 issues per year and want to switch between the well-known thematic newsletters and pure literature reviews. For our German readers, we also intend to facilitate reading of the newsletter by German translations, depending on our capacities.

In the present newsletter we would like to highlight the work of our environmental health laboratory at the State Health Office of Baden-Württemberg. A main focus of this laboratory, which has been headed by Dr. Guido Fischer since 2011, is directed to the analysis and evaluation of indoor mould contamination. Since then, the State Health Office has also undertaken the task to ensure a sufficient quality assurance for identification and exposure assessment of indoor moulds by organizing and performing international interlaboratory proficiency tests (round robin tests). In 2014, the State Health Office performed the 27th round robin test for identification of fungi with international participation. In our first technical contribution of the present newsletter, we will report on the experiences we gained there.

In this context, of course, the question on possible health implications of indoor mould contamination arises. So far, there is a scientific consensus that dampness and mould are associated with an increased risk of respiratory diseases and allergies. Thus, the WHO report "Environmental burden of disease associated with inadequate housing" (2011), based on data

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from 45 countries of the European region, estimated that 0.07 asthma-related deaths and 50 asthma-related DALYs per 100 000 children per year were associated with exposure to dampness in dwellings, and that 0.06 deaths and 40 DALYs per 100 000 children per year were associated with exposure to mould. The exact mechanism of how these factors are interrelated, however, is not fully understood. For this reason, the Baden-Wuerttemberg State Health Office has conducted a study on the relationships between mould contamination, health effects and sensitization to mould allergens in 10-years old children during the last three years. First results from these studies, will be presented in our second contribution.

As shown not only in this study, there are still significant deficits in allergy diagnosis of moulds: Do we at all examine the right mould species? In routine diagnostics mostly moulds are used which occur mainly in outdoor air. In the preparation of allergen extracts for allergy testing of moulds many aspects have not yet been sufficiently clarified. Should the allergens be isolated from the spores or from the mycelium? What is the influence of the cultivation conditions on the allergen extracts? As long as there is not sufficient clarity, it is not surprising that the results on the sensitization to moulds depend to a large extent on the different test kits of the producers, and different studies often are hardly comparable with each other. This underlines the importance of quality assurance measures in the field of mould and allergy diagnosis. Here, a closer communication and cooperation between producers of diagnostic tools, research institutions and laboratories and the practicing allergists must be done in the future, so that the validity of such studies can be improved.

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Interlaboratory proficiency test on the identification of fungi carried out by the State Health Office Baden-Württemberg (LGA-BW)

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Introduction

Since 2001, the State Health Office Baden-Württemberg (Landesgesundheitsamt Baden-Württemberg) has carried out an Interlaboratory Proficiency Test (round robin test) for the identification of microfungi entitled "Identification of indoor and food-borne fungi". This round robin test can be used as a basic quality control measure to assure a reliable identification and evaluation of indoor mould contaminations. Initially, the start-up of the round robin test was financially supported by the Federal Environmental Agency (UBA), but the long-term financing is now based on the fees for participation. Meanwhile, in spring 2014 the 26th test has been carried out. The organization and execution of the proficiency test have been supervised by Dr. Guido Fischer since 2010 (Occupational medicine and environmental health, section Analytical Quality Control).

Usually, the number of participants ranges from about 50 to about 70. Most of the laboratories participate once per year. The quality control test was established for laboratories within Baden-Württemberg, but is meanwhile widely accepted in Germany. To our knowledge, there is no other round robin test within Europe (nor worldwide) dealing with indoor- and food-borne fungi. Thus, laboratories from different countries within Europe have participated regularly, i.e. Finland, Sweden, the Netherlands, Luxembourg, Spain, Portugal, Switzerland, Austria, Hungary, and Slovenia.
In this way, the WHO Collaborating Centre for Housing and Health at the Baden-Württemberg State Health office also assists WHO activities against dampness and mould by establishing quality standards for measurement, identification and evaluation of indoor mould. Moreover, it aims to include

additional mycological laboratories from Eastern European countries into the proficiency test. The intention is to promote capacity building of WHO for mycological laboratories (indoor mycology) also in Eastern European Countries by offering free of charge access to the interlaboratory proficiency test (round robin test) and workshops and courses on identification of fungi for a limited number of participants from Eastern Europe.

Organisational aspects

The participation in this interlaboratory test is voluntary. There is so far no legal liability for participation in Germany. However, the interlaboratory proficiency test is becoming increasinly important as an external quality control measure for those mycological laboratories that want to achieve an accreditation.
The participating laboratories must provide a signed certificate that they have done the inter laboratory test autonomously, without assistance of other laboratories, institutes or external staff. In addition, the labs need written permission to handle pathogenic microorganisms of risk group 2 (BSL 2) (in Germany granted by Federal Government according to the German law on infection control, "Infektionsschutzgesetz § 44, 20 July 2000).

Samples:
Each set of test includes six strains of fungi (as pure cultures) relevant for indoor environment or food. A number of species is often found on interior finishes and building materials of indoor environments in connection with dampness and humidity. Thus the state health office (LGA) had compiled a list of fungi, that have a high indication for dampness: i.e. Acremonium spp., A. penicillioides, A. restrictus, A. versicolor, Chaetomium spp., Phialophora spp., Scopulariopsis brevicaulis, S. fusca, Stachybotrys chartarum, Engyodontium album, Trichoderma spp. Apart from these, there are about 80 to 100 different species to be expected in indoor environments, most of which will be included in the round robin test (see Table 1). The fungal strains are inoculated on slants in double, so that one slant can be kept as retain sample for quality control purposes.
It is intended to include at least four strains, which are reasonable with respect to the level of difficulty. At least one of the strains can be somewhat more difficult to identify, so that the round robin test also achieves an educative effect.
In addition, the participants can order a **mixed sample** containing three or four species in different concentrations. The spectrum of fungi varies from test to test. This mixture is prepared approximately 2 to 3 month in advance of each test. During this time, the mixture is analyzed every two to three weeks to monitor the reproducibility of the sample.
The following explanations refer to the pure cultures only in order to cover the qualitative aspect of fungal identification sufficiently.

Internal quality control:
Internal quality control measures to guarantee the purity and identity of the strains is achieved by regular controls. Prior to the sending the test strains, pure cultures are checked for purity and typical morphological characteristics by six reference laboratories. Only strains correctly identified by all reference laboratories will be sent out to the participating laboratories. All reference laboratories also participate in the proficiency test, to assure that all isolates are of high quality when sent out. Apart form the LGA BW (Dr. Guido Fischer) the reference laboratories were the following:

- Dr. Hans Peter Seidl, Lehrstuhl für Mikrobiologie, Klinik für Dermatologie und Allergologie, TU München, Biedersteinerstraße 29, 80802 München
- Prof. Dr. Robert A. Samson, Centraalbureau voor Schimmelcultures (CBS), Uppsalalaan 8, 3584 CT Utrecht, The Netherlands
- Dr. Christiane Baschien, Umweltbundesamt, Corrensplatz 1, 14195 Berlin
- Dr. Christoph Trautmann, Umweltmykologie GbR, Zossenerstraße 56-58, 10961 Berlin
- Dr. Susanne Janich-Grün, Eco-Luftqualität + Raumluft, Sachsenring 69, 50677 Köln

Scoring of results and evaluation:
Pure cultures: For a successful participation, the laboratories must identify at least 4 out of 6 fungal strains correctly to the species level. This means that the identification on the genus level is not sufficient. The results must be submitted within six weeks.
The mixed sample is scored depending on the number of species mixed and the level of difficulty. Mostly, 2 of **three** or 3 of **four** species in the mixture must be identified to the species level and, in addition, be quantified correctly according to ISO 16000-17. The analysis of the mixed sample is optional for the participants, so that not all participants order it. Furthermore, the correct quantification of the fungi is evaluated in addition to the correct identification. These aspects will be addressed in a separate publication.

Evaluation of results and feedback:
Once per year (February/March) a workshop is organized, where the participants are informed about the results of the proficiency test. The workshop has been carried out 12-times so far. Here, the participants have the opportunity to do practical work on a selected group of fungi and can reinvestigate the strains from the two preceding round robin tests.

Results

Performance of labs:
When the six species of each round robin test are grouped from 1 to 6 according to the decreasing percentage of correct identifications (Table 2, highest = 1, to lowest = 6), the performance of the participating laboratories can be evaluated on a timely scale. The percentage of correct identification was relatively constant throughout the years 2001 to 2014 for the species/strains 1 to 5 (Table 2). For the "easiest" strain, it was mostly above 85 %, resulting in a mean of 90%. The mean percentages decreased to almost 85% for the second "easiest" species, followed by 77% for the third, 71% for the fourth, and 64% for the fifth "easiest" species.
Some kind of turning point becomes visible for the most difficult species (species 6) from the 18th round robin test onwards (RV 18, see Table 2). While the percentage of correct identifications mostly varied between 40% and 75% until 2009, it often has ranged only between 20 and 30 % since 2010. Since 2010, an "educative" strain, that was somewhat more challenging to identify, has been included into the round robin test.
Consequently, the question arises, if such changes in the degree of difficulty influence the overall performance of the participating labs.
For this purpose, the performance of the participating labs was analyzed by comparing the percentages of labs with 6, respectively 5 or 4 correct identifications (Fig. 1, Table 3). The percentage of successful participation varies from 50 % to 95%, mainly depending on the set/composition of species sent out, but changes do not get obvious at the first sight for the period after 2009. This indicates that the change of difficulty in one strain (species No. 6) does not directly influence the overall performance of the labs.

However, the effects gets more clear, when the performance of the labs is grouped according to the number of correct identifications from 6 down to 0 (Table 3). The number of labs participating with 6 correct identifications decreases, while the number of labs with 5 and 4 correct identifications slightly increases. Consequently, the total number of labs passing the test has not changed significantly due to the increase in the level of difficulty in species 6.

The difficult species:
The most challenging species for the laboratories were the following (percentage of correct identifications given in brackets): *P. digitatum* (7%, 20%), *Penicillium crustosum* (31%), *Scopulariopsis brumptii* (23 %), *Phialophora europaea* (31%), and *Talaromyces piceus* (26%). In general, species from the genus *Penicillium* are quite difficult to identify. The percentage of correct identifications often is near 50% and the number of incorrect results given by the participants is quite high.
The efficacy of the quality control aspect of the round robin test can best be observed, when more difficult strains are sent out repeatedly. The first example was *P. digitatum*, for which the percentage

of correct identification increased from 7% (RV 1) to 20% (RV 2), then to 88 % (RV 12) and 84 % (RV 18). Another example is *A. restrictus*, which increased from 39% (4. RV) to 60% (RV 8) and further to 83 % and 71% in the RV 11 and RV 15, respectively. *Talaromyces funiculosus* showed also a quite impressive percentages, starting with 54% in RV 18, followed by 87% in RV 25.

The "educative" strains:
A second educative effect concerns the inclusion of more difficult genera in the round robin test, i.e. *Verticillium, Scopulariopsis, Phialophora* or *Alternaria* spp. In these genera the taxonomy is currently under change, either because sequence databases are build up in recent studies, or because nomenclatural changes occurred in the last years.
The educational effect of this round robin test is also supported by the regular workshop, where the results of the two preceding round robin tests are presented and discussed with the participants once a year.

Discussion and evaluation

The interlaboratory proficiency test increases the quality of the identification and evaluation of indoor fungi significantly. The educational effect concerning the identification of pure cultures gets visible when difficult species are sent out repeatedly (e.g. *Penicillium digitatum, Aspergillus restrictus*).
The round robin test carried out by the LGA improves good laboratory practice (GLP) and the quality assurance (QA) in two ways: 1. It guarantees a high level quality of routine identification work done with the frequently occurring species. Secondly, the educative strain assures that the mycological expertise in the laboratories is permanently widened by including new species/genera. The latter aspect is supported by the regular workshops held once every year, as it presents new trends in fungal taxonomy (new genera or species) as well as aspects of analytical QA.
The average percentage of laboratories passing the round robin test with 6 or 5 points is nearly 50%. These laboratories have proved to do fungal identification on a high level. It is exactly these 50% of the laboratories, which appreciate the "educative" strain to improve their expertise constantly.
Mycological expertise is also supported by the courses on fungal identification organized by the LGA in cooperation with the CBS.

The benefits of the interlaboratory proficiency test offered by the LGA BW can be summarized as follows:

- The correct identification of a fungal species is a prerequisite for a reliable evaluation of health risks. It will help to decide, if a species is relevant as infectious agent especially for immunocompromised people (e.g. *Aspergillus* spp. complex or *Fusarium* spp. as rare opportunistic fungi). On the other hand, the allergenic potential of a species can be determined or at least estimated. Unfortunately, there is a lot of indoor fungi, that can not be considered for allergy diagnostics, because allergenic proteins are not known or diagnostic test kits are not available. There is a urgent need in public health for adequate allergy testing of indoor fungi.
- The correct identification of indoor fungi is a prerequisite to assess the exposure to fungi in indoor environments more accurately. This aspect concerns both the qualitative and the quantitative exposure assessment. To study the exposure situation in both damp buildings and reference buildings in detail is the basis for establishment of cause-effect relations.
- The correct and reliable identification of fungi is a prerequisite for the accreditation of a mycological laboratory. The working process in the laboratories determines the identification results basically, especially because fungal identification is based on microscopy of hand-made preparations and identification with group-specific literature and keys. The quality of the hand-made preparation is essential for the identification result and the evaluation of the morphological structures under the microscope basically depends on the working skills of the lab personnel.

The quantitative analysis of the mixed sample (data not presented) is an effective tool to guarantee reliable quantification as a basis for evaluation of indoor fungi. This aspect will be focused on in a separate publication.

Table 1: The list includes filamentous fungi and yeast that are relevant in indoor environments or food and that can be send out in the round robin test. It must be considered that also species not included here can be send out, e.g. as educative strains. Species already sent out are marked in blue. The numbers in brackets indicates the proficiency test where it was sent out.

Absidia (Lichtheimia) corymbifera (6, 21)
Acremonium kiliense
Acremonium muro rum (3, 15)
Acremonium strictum
Alternaria alternata
Alternaria tenuissima (20)
Aspergillus carbonarius (24)
Aspergillus chevalieri (Eurotium chevalieri)
Aspergillus creber * (20)
A. glaucus (Eurotium herbariorum) (25)
Aspergillus fumigatus (3, 10)
Aspergillus nidulans (Emericella) (1, 11, 22)
Aspergillus niger (8)
Aspergillus penicillioides (1, 9)
Aspergillus restrictus (4, 8, 11, 15)
Aspergillus rubrobrunneus (Eurotium rubrum)
Aspergillus sydowii (5, 13, 14, 19)
Aspergillus tamarii (11)
Aspergillus terreus (7)
Aspergillus ustus (4)
Aspergillus calidoustus (22)
Aspergillus versicolor (2, 11, 20)
Aspergillus vitis (Eurotium amstelodami) (2, 9)
Aspergillus wentii
Aspergillus westerdijkiae (25)
Aureobasidium pullulans (2, 7,12, 23)
Beauveria bassiana
Botrytis cinerea (7)
Byssochlamys nivea
B. spectabilis (Paecilomyces variotii) (6, 12, 18)
Cadophora fastigiata (= Phialophora fast.) (7)
Phialophora europaea (24)
Chaetomium globosum (3, 10, 13)
Chrysonilia crassa
Chrysonilia sitophila
Chrysosporium sp.
Cladosporium cladosporioides (3)
Cladosporium herbarum (16)
Cladosporium sphaerospermum (5, 13, 24)
Curvularia geniculata
Clonostachys rosea (23)
Doratomyces sp.
Geomyces pannorum (5, 12, 16, 25)
Lecanicillium lecanii (Verticillium lecanii) (18)
Microascus (Scopulariopsis) brevicaulis (1, 10)
Mucor hiemalis (17)
Mucor plumbeus (7, 13, 22)
Mucor racemosus (2, 19)
Oidiodendron griseum (17)
Penicillium citrinum (21)
Penicillium digitatum (1, 2, 5, 12, 18)
Penicillium commune (14)
Penicillium corylophilum (8, 21)
Penicillium crustosum (19)
Penicillium expansum (4, 13, 15)
Penicillium glabrum (6, 10)
Penicillium griseofulvum (18, 26)
Penicillium olsonii (4, 9, 23)
Penicillium roqueforti (8, 22)
Phoma glomerata (4, 14)
Phoma macrostoma
Rhizopus stolonifer (1, 10, 26)
Rhodotorula minuta
Scopulariopsis brumptii (21)
Stachybotrys echinata (Memnoniella echinata) (26)
Stemphylium botryosum
Syncephalastrum racemosum (3, 15)
Talaromyces funiculosus (18, 25)
Talaromyces piceus (26)
Talaromyces purpurogenus (3, 15)
Talaromyces rugulosus (7, 15)
Talaromyces variabilis
Trichoderma harzianum
Trichoderma longibrachiatum complex (14)
Trichoderma viride
Trichothecium roseum (6, 19, 26)
Ulocladium chartarum
Verticillium luteoalbum
Wallemia sebi (1, 17,21)

Legend: *Species from the *A. versicolor* species complex was not yet described in 2011

Table 2: The six species sent out in each round robin test (RV) grouped according to the percentage of correct identification (Cor. ID) from year 2001 to 2014. Mean value (mean) and standard deviation (std. dev.) were calculated for two different periods of time (2001 - 2009; 2010 - 2014).

RV No.	Year	Species 1	Cor. ID (%)	Species 2	Cor. ID (%)	Species 3	Cor. ID (%)
1. RV	2001	Wallemia sebi	93	Rhizopus stolonifer	91	Emericella nidulans	86
2. RV	2002	Aureobasidium pullulans	87	Mucor racemosus	87	Penicillium chrysogenum	67
3. RV	2002	Aspergillus fumigatus	93	Syncephalastrum racemosum	83	Chaetomium globosum	81
4. RV	2003	Aspergillus candidus	92	Phoma glomerata	68	Aspergillus ustus	58
5. RV	2003	Scopulariopsis fusca	81	**Aspergillus sydowii**	81	Aspergillus flavus	80
6. RV	2004	Trichothecium roseum	99	Paecilomyces variotii	82	Penicillium glabrum	79
7. RV	2004	Mucor plumbeus	93	Aspergillus terreus	93	Epicoccum nigrum	93
8. RV	2005	Aspergillus niger	97	Geotrichum candidum	92	Penicillium corylophilum	70
9. RV	2005	Aspergillus ochraceus	82	Eurotium amstelodami	79	Penicillium olsonii	70
10. RV	2006	Rhizopus stolonifer	98	Scopulariopsis brevicaulis	90	Aspergillus fumigatus	90
11. RV	2006	Aspergillus ochraceus	98	Aspergillus candidus	96	**Aspergillus restrictus**	84
12. RV	2007	Geotrichum candidum	100	Aureobasidium pullulans	98	Geomyces pannorum	89
13. RV	2007	Chaetomium globosum	91	Mucor plumbeus	83	Cladosporium sphaerospermum	64
14. RV	2008	**Aspergillus sydowii**	81	Trichurus sp.	73	Phoma glomerata	73
15. RV	2008	Syncephalastrum racemosum	91	**Aspergillus restrictus**	71	Penicillium rugulosum	52
16. RV	2009	Geomyces pannorum	80	Eurotium chevalieri	70	Tritirachium oryzae	65
17. RV	2009	Aspergillus candidus	96	Wallemia sebi	96	Penicillium camemberti	93
18. RV	2010	Paecilomyces variotii	90	Aspergillus clavatus	90	**Penicillium digitatum**	85
19. RV	2010	Trichothecium roseum	93	Mucor racemosus	91	**Aspergillus sydowii**	86
20. RV	2011	Geotrichum candidum	98	**Aspergillus versicolor**	71	Scopulariopsis candida	68
21. RV	2011	Wallemia sebi	86	Absidia corymbifera	82	Eurotium herbariorum	77
22. RV	2012	Penicillium camemberti	85	Mucor plumbeus	83	Emericella nidulans	81
23. RV	2012	Aureobasidium pullulans	92	Eurotium chevalieri	83	Penicillium olsonii	75
24. RV	2013	Aspergillus carbonarius	69	Cladosporium sphaerospermum	69	Penicillium brevicompactum	65
25. RV	2013	Talaromyces funiculosus	87	Geotrichum candidum	86	Geomyces pannorum	84
26. RV	2014	**Trichothecium roseum**	**97**	Epicoccum nigrum	90	Stachybotrys echinata	87
Mean (1. - 17. RV)			91		84		76
Std. dev. (1. - 17. RV)			7		10		12
Mean (18. - 26. RV)			**89**		**83**		**79**
Std. dev. (8. - 26. RV)			**9**		**9**		**11**
Mean of all			**90**		**84**		**77**

RV No.	Year	Species 4	Cor. ID (%)	Species 5	Cor. ID (%)	Species 6	Cor. ID (%)
1. RV	2001	Scopulariopsis brevicaulis	86	Aspergillus penicilloides	72	**Penicillium digitatum**	7
2. RV	2002	**Aspergillus versicolor**	58	Eurotium amstelodami	56	**Penicillium digitatum**	20
3. RV	2002	Stachybotrys chartarum	81	Cladosporium cladosporioides	79	Acremonium murorum	62
4. RV	2003	Penicillium olsonii	49	Penicillium expansum	49	**Aspergillus restrictus**	39
5. RV	2003	Cladosporium sphaerospermum	73	Geomyces pannorum	67	**Penicillium digitatum**	67
6. RV	2004	Absidia corymbifera	76	Eurotium herbariorum	66	Candida albicans	66
7. RV	2004	Botrytis cinerea	87	Aureobasidium pullulans	80	Penicillium rugulosum	54
8. RV	2005	Scopulariopsis fusca	69	**Aspergillus restrictus**	61	Penicillium roqueforti	55
9. RV	2005	Aspergillus penicillioides	70	Penicillium brevicompactum	68	Paecilomyces lilacinus	48
10. RV	2006	Chaetomium globosum	88	Penicillium glabrum	88	Penicillium chrysogenum	77
11. RV	2006	Emericella nidulans	78	**Aspergillus versicolor**	78	Aspergillus tamarii	47
12. RV	2007	**Penicillium digitatum**	86	Paecilomyces lilacinus	66	Paecilomyces variotii	66
13. RV	2007	Penicillium chrysogenum	64	**Aspergillus sydowii**	61	Penicillium expansum	56
14. RV	2008	Penicillium decumbens	67	Trichoderma Sektion longibrachiat	54	Penicillium commune	44
15. RV	2008	Acremonium murorum	50	Paecilomyces lilacinus	47	Penicillium expansum	47
16. RV	2009	Engyodontium album	59	Penicillium italicum	57	Cladosporium herbarum	51
17. RV	2009	Oidiodendron griseum	80	Mucor hiemalis	71	Penicillium citreonigrum	53
18. RV	2010	Penicillium griseofulvum	58	Penicillium funiculosum	54	**Verticillium lecanii**	**29**
19. RV	2010	Fusarium solani	76	Penicillium nalgiovense	76	**Penicillium crustosum**	**31**
20. RV	2011	Penicillium hirsutum	54	**Aspergillus versicolor**	53	**Alternaria tenuissima**	**20**
21. RV	2011	Penicillium citrinum	68	Penicillium corylophilum	63	Scopulariopsis brumptii	23
22. RV	2012	Engyodontium album	81	Penicillium roqueforti	65	Aspergillus calidoustus	52
23. RV	2012	Curvularia lunata	67	Botryosporium sp.	60	Clonostachys rosea	54
24. RV	2013	Acrostalagmus luteoalbus	63	Zygorrhynchus moelleri	41	**Phialophora europaea**	**31**
25. RV	2013	Aspergillus glaucus	80	Penicillium nalgiovense	75	Aspergillus westerdijkiae	58
26. RV	2014	Rhizopus stolonifer	85	Penicillium griseofulvum	59	**Talaromyces piceus**	**26**
Mean (1. - 17. RV)			72		66		50
Std. dev. (1. - 17. RV)			13		11		17
Mean (18. - 26. RV)			**70**		**61**		**36**
Std. dev. (8. - 26. RV)			**12**		**11**		**17**
Mean of all			**71**		**64**		**45**

Table 3: The performance of the laboratories during the years 2001 to 2014 grouped according to the points reached (6 to 0 points). The round robin test (RV) was passed successfully, when 4 or more species were correctly identified (4 - 6 points reached). Mean value (mean) and standard deviation (std. dev.) were calculated for two different periods of time (2001 - 2009; 2010 - 2014).

RV No.	Year	No. of participants	Percentage passed (%)	6 Points	5 Points	4 Points	3 Points	2 Points	1 Point	0 Points
				Passed the round robin test			Failed the round robin test			
1. RV	2001	44	**86**	2	51	33	12	0	0	2
2. RV	2002	46	**60**	13	16	31	22	9	7	2
3. RV	2002	45	**86**	45	24	17	7	2	5	0
4. RV	2003	65	**51**	15	22	14	19	15	12	3
5. RV	2003	66	**78**	34	27	17	6	9	5	2
6. RV	2004	62	**94**	45	30	19	0	4	1	0
7. RV	2004	69	**89**	43	24	22	11	0	0	0
8. RV	2005	77	**77**	25	22	30	20	2	2	0
9. RV	2005	67	**70**	23	30	16	13	5	13	0
10. RV	2006	47	**90**	67	13	10	6	2	2	0
11. RV	2006	57	**85**	29	42	15	13	0	2	0
12. RV	2007	47	**91**	45	25	20	7	2	0	0
13. RV	2007	64	**73**	22	19	33	16	6	3	2
14. RV	2008	64	**62**	21	21	19	17	10	12	0
15. RV	2008	58	**50**	12	26	12	24	12	10	3
16. RV	2009	69	**64**	17	26	20	12	13	4	7
17. RV	2009	61	**95**	35	36	24	2	0	0	4
18. RV	2010	59	**71**	15	31	25	6	8	12	4
19. RV	2010	58	**83**	26	33	24	10	2	3	2
20. RV	2011	59	**58**	5	24	29	20	17	5	0
21. RV	2011	65	**69**	18	29	22	11	9	5	6
22. RV	2012	52	**79**	37	27	17	4	2	8	6
23. RV	2012	52	**73**	23	33	17	13	8	4	2
24. RV	2013	49	**51**	10	16	24	22	12	6	8
25. RV	2013	69	**87**	41	22	25	7	3	0	3
26. RV	2014	61	**85**	16	39	30	7	3	2	3
Mean (1. - 17. RV)		59	76	29	27	21	12	5	5	1
Std. dev. (1. - 17. RV)		10	15	16	9	7	7	5	4	2
Mean (18. - 26. RV)		**58**	**73**	**21**	**28**	**24**	**11**	**7**	**5**	**4**
Std. dev. (18. - 26. RV)		**6**	**14**	**15**	**9**	**6**	**7**	**5**	**4**	**2**
Mean of all		**59**	**75**	**26**	**27**	**22**	**12**	**6**	**5**	**2**

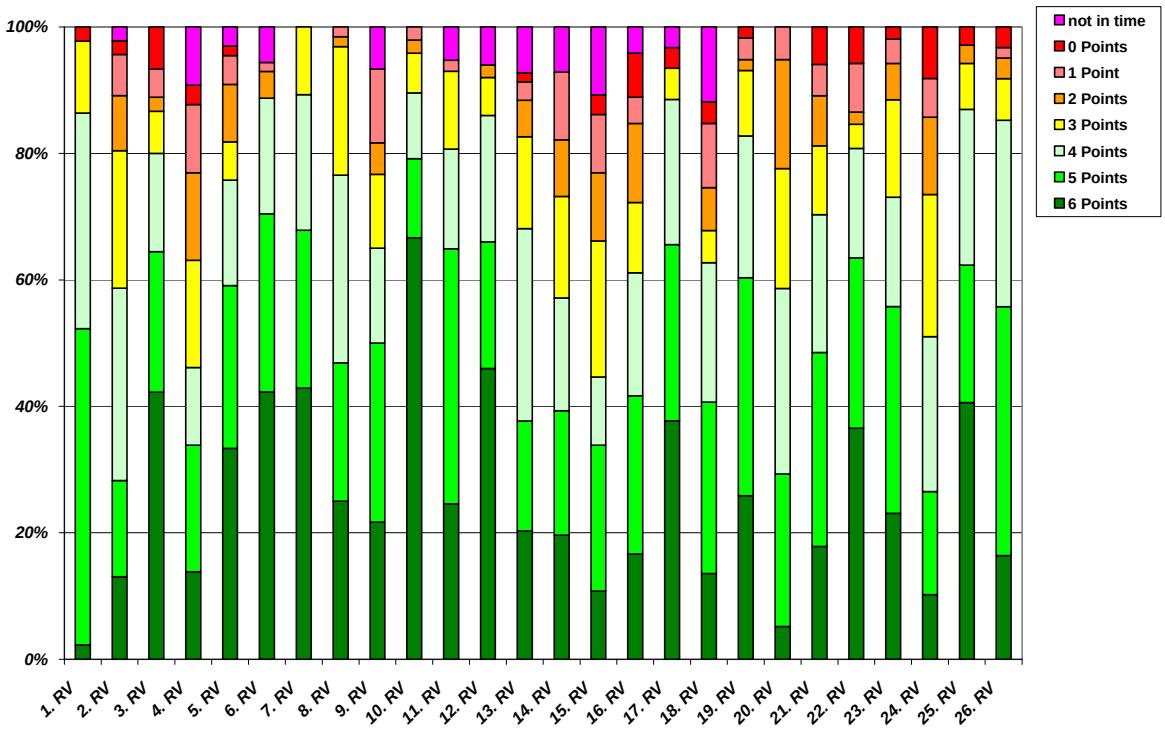

Figure 1: Number of correct identifications of the participating laboratories from the 1st round robin test (RV 1 in 2001) to 26th (RV 26 in 2014). A minimum of 4 correct identifications (4 points) must be reached to pass the proficiency test successfully (indicated by green colours).

Relevance of Indoor fungi as allergens

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Dampness and mould in indoor environments are commonly regarded as risk factors for asthma and allergies. Moreover, microfungi in indoor environments can trigger an enhanced reaction of the immune system by release of specific antibodies of the IgE class (sensitization). The state health office Baden-Württemberg (LGA) has studied the prevalence of sensitization against indoor fungi in 10-year old children (fourth graders) during the last three years.

Several epidemiological studies showed that damp and mouldy indoor environments are associated with an increased risk for airway symtoms in residents. A similar trend has been observed in invesigations of the LGA that have been carried out since 1996 in a health monitoring program in cooperation with the local health authorities (so called „Beobachtungsgesundheitsämter“). Here, a 1.7-times higher risk for wheezing resulted in flats, where the parents reported dampness or visible mould.In addition, the effect clearly depended on the extension of mould growth (Figure 8) and allergies and asthma were reported more frequently in these flats (Figures 9, 10)
Until now, there is little evidence for the fact that the indoor fungi itself can trigger allergies. The so called children-environment survey (Kinder-Umwelt-Survey) initiated by the UBA carried out from 2003 to 2006 investigated more than 1.500 children at the age of 3 to 14 years for the level of specific antibodies in blood. 8.3% of the children showed a sensitization against at least one indoor mould.
On the background of these results the LGA carried out a study in fourth-graders during the winter season of 2011/12, 2012/13, and 2013/14, respectively. A total of 1.308 children from the district of Ravensburg, Offenburg, Emmendingen, and Ludwigsburg were included in the study. Blood samples for analysis of specific IgE-antibodies against indoor fungi could be taken from a number of 737 children (Table 1). While 3.5% (95th CI: 2.3 - 5.1 %) of the children were sensitized to a mixture of four species *(mx1: Penicillium chrysogenum, Cladosporium herbarum, Aspergillus fumigatus, Alternaria alternata)*, only 0.8% showed specific sensitization to *Peniclillium chrysogenum* (95. CI: 0.3 - 1.8 %), which is a typical humidity indicator in damp buildings. The sensitization rate for two other humidity indicators (*Aspergillus versicolor, Chaetomium globosum*) was even lower with less than 0.1%. These sensitization rates are similar to those found in a study with adults in 2010/11.
Thus, our results differ markedly from the data of the „Kinder-Umwelt-Survey“. However, it must be considered that two different kinds of tests had been used in the studies for determination of the IgE levels. The method used in our study is widely used in clinical practice, while the test used in the UBA-study was newly developed with other fungal strains. If the different methods used for quantification of IgE antibodies or other factors (e.g. region) are responsible for the differences in sensitization rates, must be investigated in future studies. A comparison of different methods for IgE-quantification is planned by reinvestigation of stored sera.
As long as the cause-effect-relations between fungal exposure and the development of sensitization and allergy are not thoroughly understood, the strict prevention of dampness and mould is the only effective measure against the development of allergies. Statistical analysis of different factors concerning the housing conditions and their connection with the extent of mould growth, have resulted in some interesting findings listed in the following:

- The percentage of flats with dampness and/or mould problems was comparable throughout the three years of investigation and ranged between 11 and 14% (Figure 1).
- In 6 % of the flats where “mould problems“ were reported, the extent of fungal growth was below 0,02 m^2 (Figure 2), which equals 200 cm^2 and has the same extent as a 2 m silicon seal of 1 cm width. Surface areas with mould contamination of such extent can be found in nearly every household and were thus defined as background contamination. Consequently, in 7% of the households, the extend of fungal contamination was reported to be above that background level. This means, that approximately 7% of the flats showed an increased exposure.
- There is a clear trend recognizable, that buildings/flats constructed during the 1950s to 1980s are more frequently affected by mould growth (22%) than buildings constructed after 1980

(11%) (Figure 3). Moreover, apartment houses (22%) are more frequently affected compared to one family houses (approx. 7%) (Figure 4). In flats with stove heating the incidence of mould contamination was significantly lower (7%) compared to flats with other heating systems (17%) (Figure 6).

- The incidence of dampness and/or mould is also connected with the housing space available per resident. In flats with a maximum of 22,5 m^2 space per resident the incidence was 24%, and it decreased to 16% in flats with housing space between 22,5 and 29,25 m^2 per resident. The incidence of dampness/mould decreased to 7% in flats with more than 30m^2 per person (Figure 7). As in 6 % of the flats with "mould problems" the extent of fungal growth was at background concentration (Figure 2), it is likely that the majority of flats with more than 30 m^2 of housing space per person had only mould growth in background concentrations.

Thus, three factors can be defined as risk factors for mould growth in indoor environments: A) Year of construction (1950s to 80s), B) Type of building (apartment buildings), and C) housing space per resident (< 30 m^2). On the other hand, stove heating obviously prevents dampness and mould.

Table 1: Prevalence of sensitization

Parametre	sx1	mx1	m1	gm25	m208
No. positive	270	26	6	1	0
Total No.	739	737	737	738	735
Percent total	36.5%	3.5%	0.8%	0.1%	0.0%
95th CI max.	40.1%	5.1%	1.8%	0.8%	0.5%
95th CI min.	33.1%	2.3%	0.3%	0.0%	0.0%

Figure 1: Percentage of flats/houses with dampness and/or mould (95th confidence interval (CI) indicated by bars). Data from the three winter seasons A) 2011/12; B) 2012/13; C) 2013/14 and D) the overall mean are illustrated.

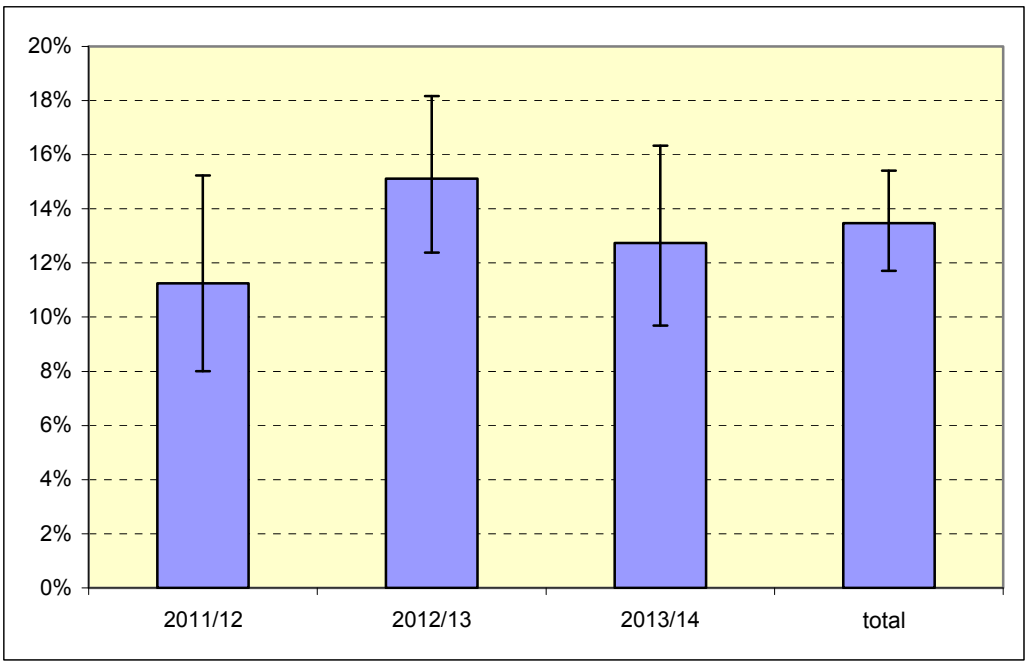


Figure 2: Incidence of dampness and/or mould analysed for the extent of contamination: B) < 0.02 m^2, C) 0.02 - 0.5 m^2, D) > 0.5 m^2 and percentage for all flats/houses (A) (95th confidence interval (CI) indicated by bars).

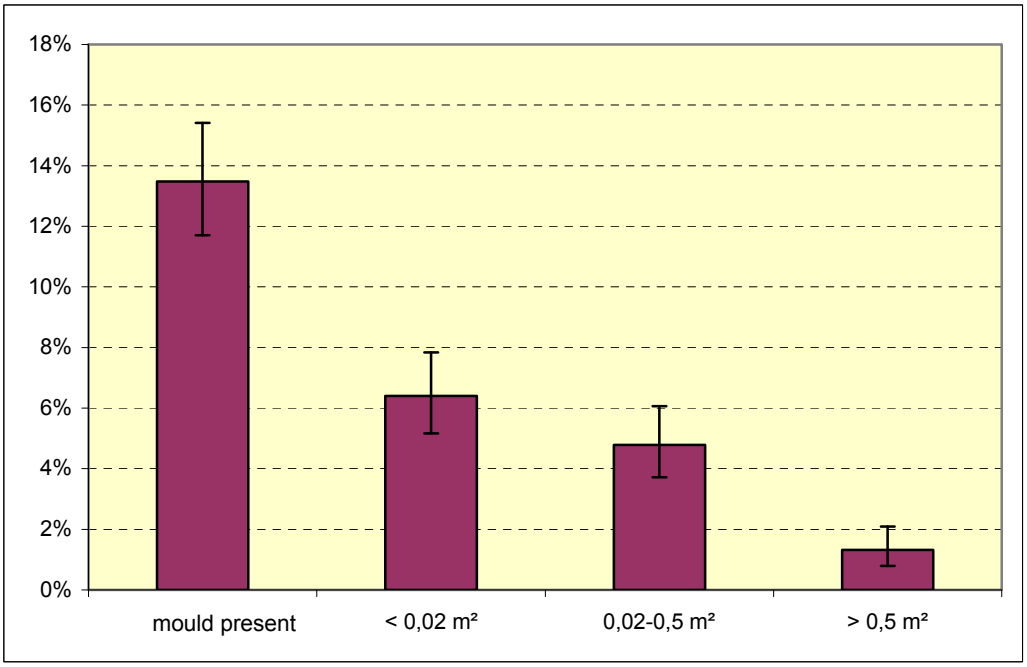


Figure 3: Percentage of flats/houses with dampness and/or mould classified for year of construction: A) before 1945, B) 1950-80, C) 1981-2000, and D) after 2001 (95th confidence interval (CI) indicated by bars).

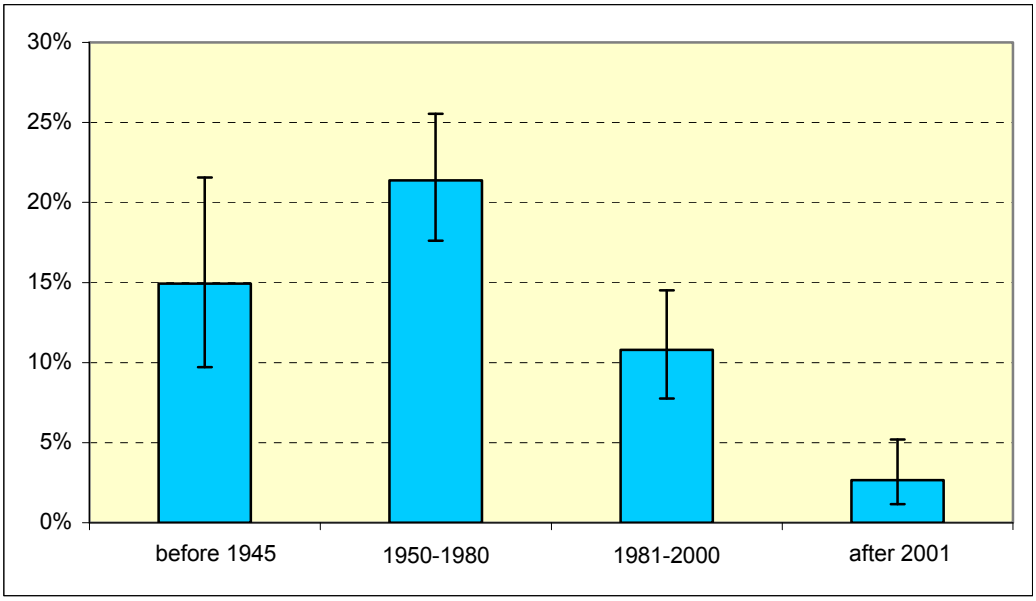


Figure 4: Percentage of flats/houses with mould classified for building type: A) single-family home; B) farm houses; C) apartment houses, and D) row houses (95th confidence interval (CI) indicated by bars).

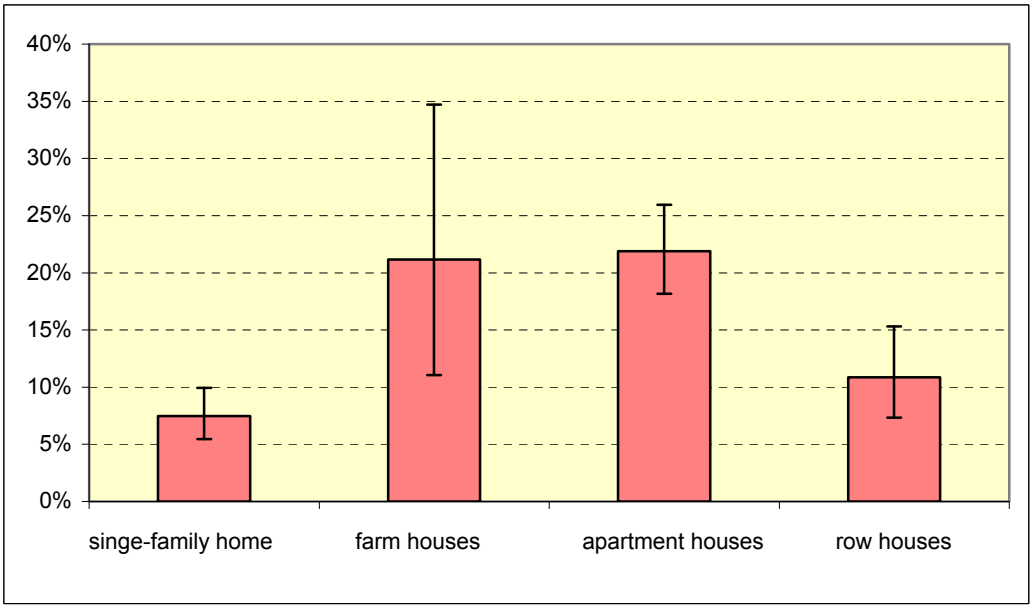


Figure 5: Percentage of flats/houses with mould classified for combustion material: A) wood/coal; B) gas; C) oil, and D) electricity (95th confidence interval (CI) indicated by bars).

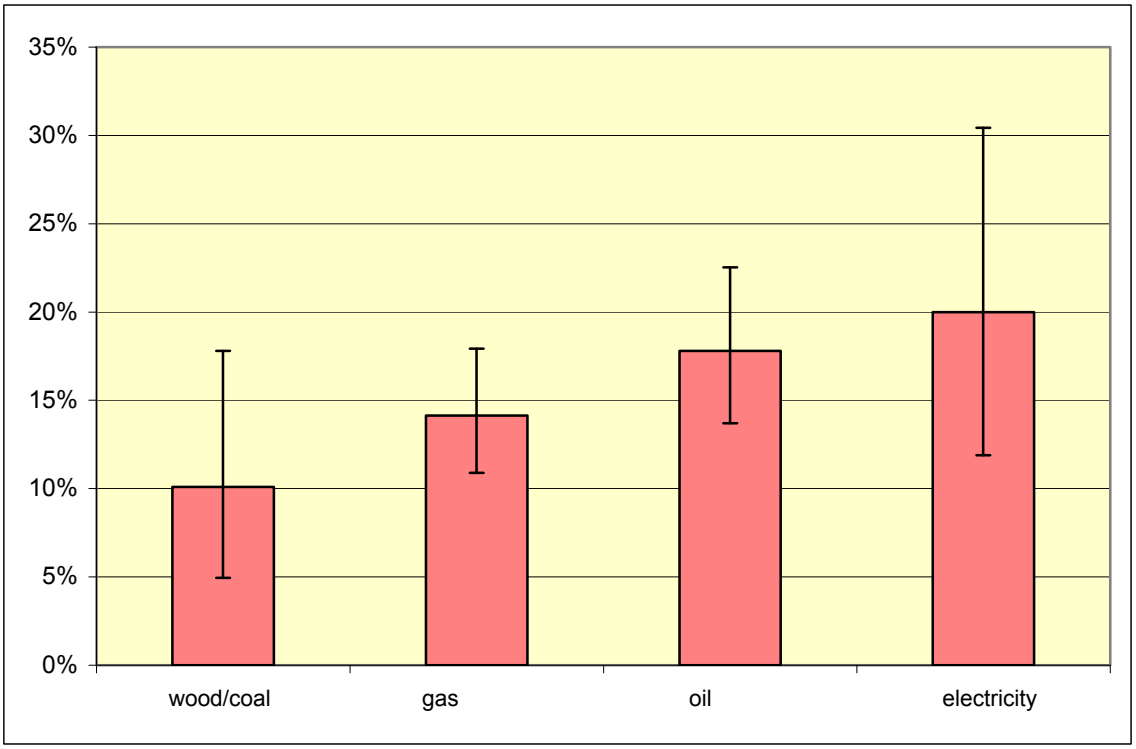


Figure 6: Percentage of flats/houses with dampness / mould classified for heating type: A) stove-heating; B) other central heating (95th confidence interval (CI) indicated by bars).

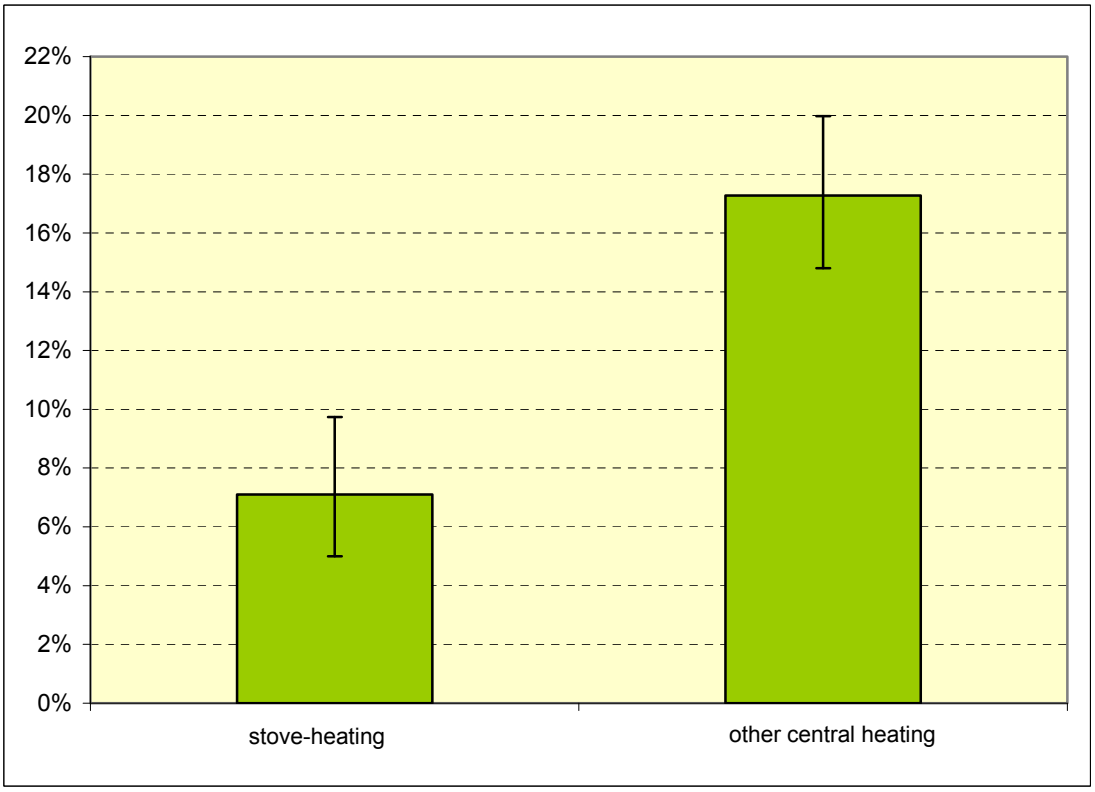


Figure 7: Percentage of flats/houses with dampness / mould classified for housing space per resident (95th confidence interval (CI) indicated by bars). Four categories have been distinguished: A) < 22.5 m^2; B) 22.5 - 29.25 m^2; C) 29.25 - 39 m^2; and D) > 36 m^2.

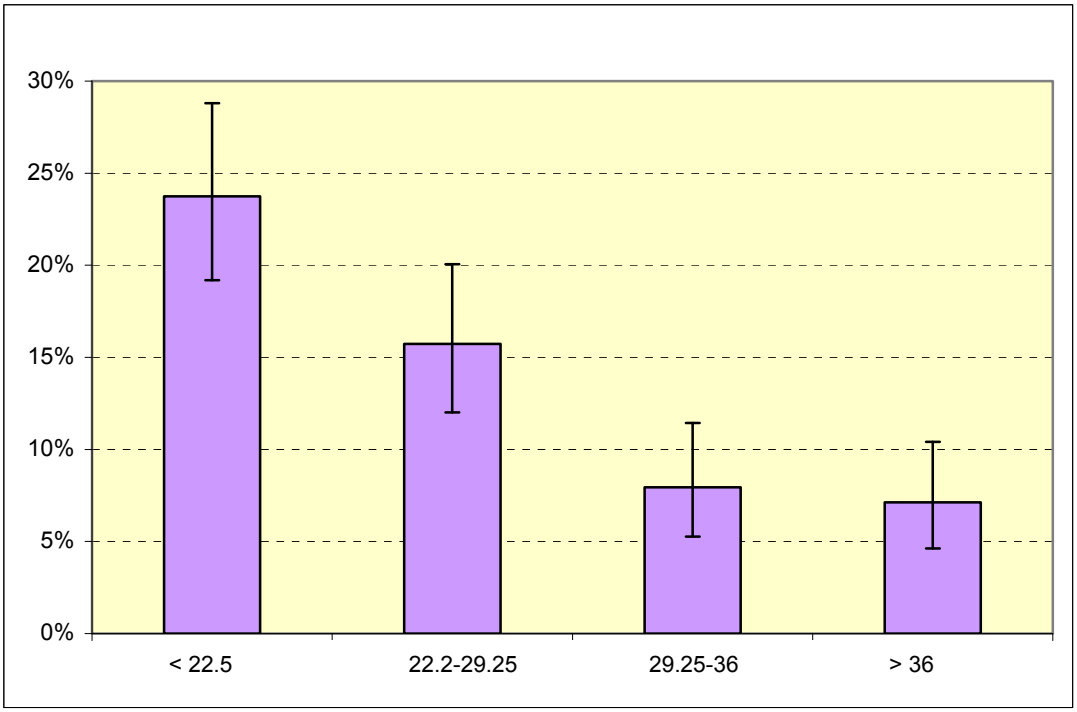


Figure 8: Relationship of dampness / mould with airway symptoms (prevalence of wheezing). Five categories have been distinguished: A) no mould; B) mould present; C) mould < post card; D) mould between post card and newspaper; E) mould > newspaper (95th confidence interval (CI) indicated by bars).

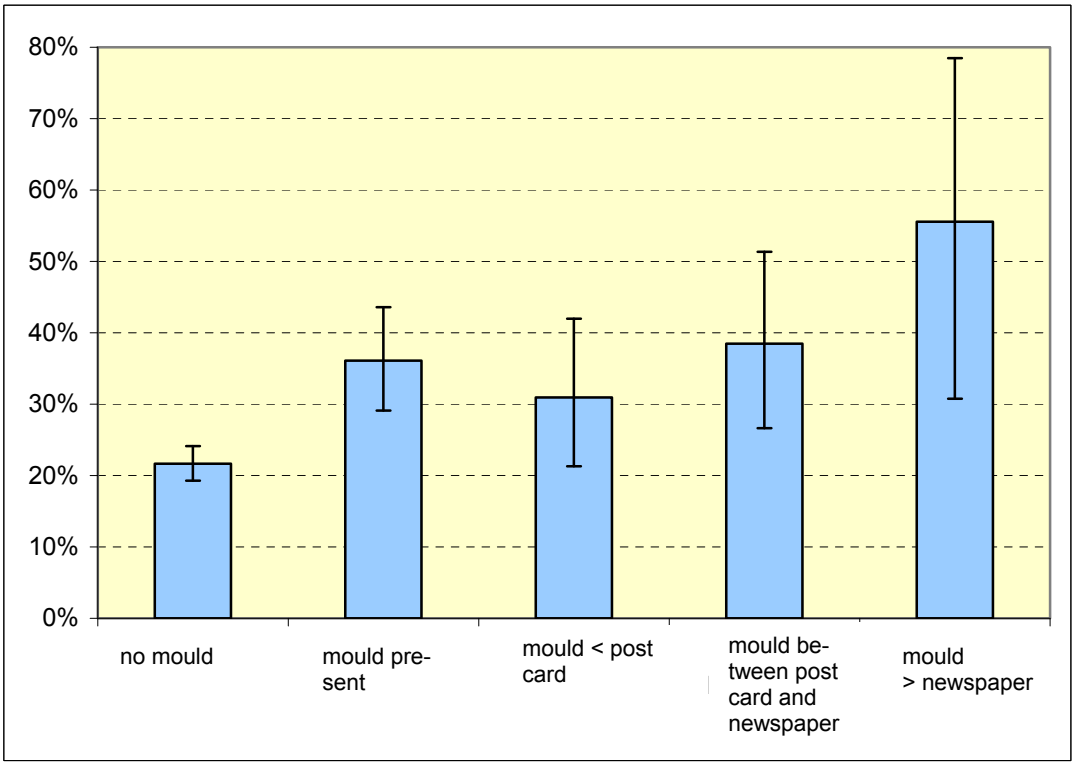


Figure 9: Percentage of children with allergy ever. Five categories have been distinguished: A) no mould; B) mould present; C) mould < post card; D) mould between post card and newspaper; E) mould > newspaper (95th confidence interval (CI) indicated by bars).

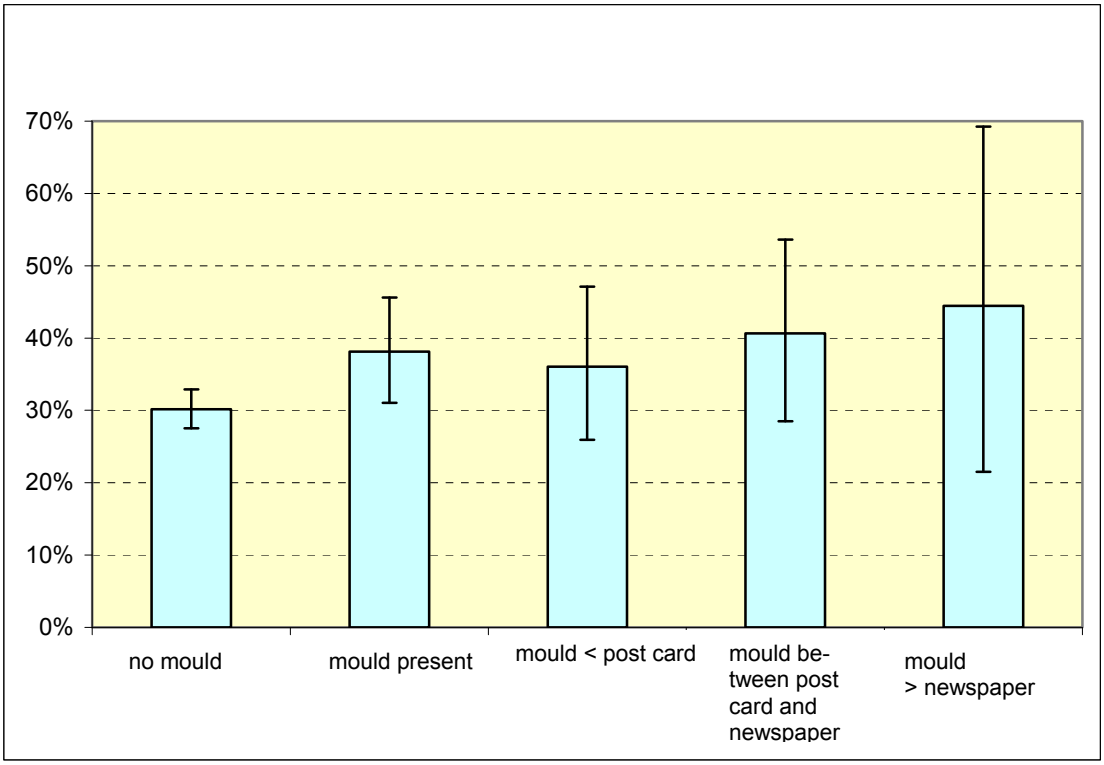
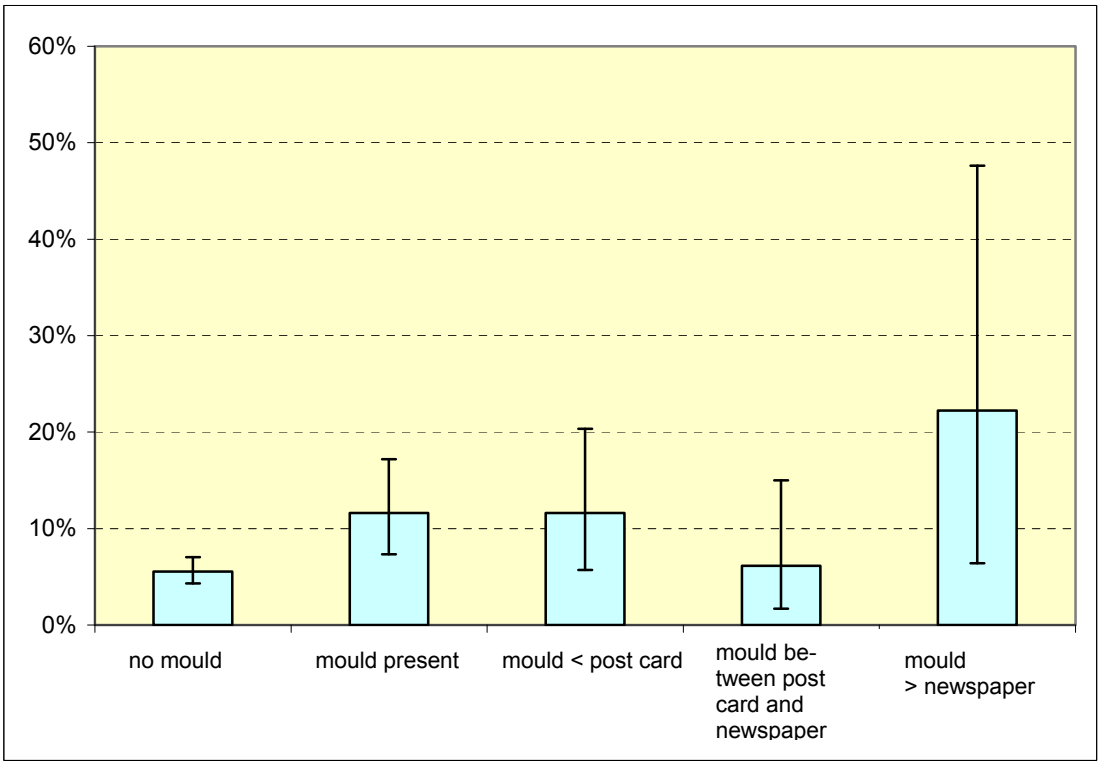


Figure 10: Percentage of children with asthma ever. Five categories have been distinguished: A) mould present; B) no mould; C) mould < post card; D) mould between post card and newspaper; E) mould > newspaper (95th confidence interval (CI) indicated by bars).



Publications and Resources

"*Ready*" - prepared for senior-friendly housing

As part of a *Future-Construction-Project*, researchers of the University of Stuttgart have developed a new model for senior-friendly housing. Under a key concept named "ready", it defines general rules for the construction of new homes that can be adapted quickly and inexpensively if the need arises, such as when a resident suddenly becomes dependent on care. The project results are now available online at www.readyhome.de, the print version of the final report can be requested free of charge by e-mail to zb@bbr.bund.de at the Federal Institute of Building, Urban Affairs and Spatial Development (BBSR).

Feasability study on the effects of infrasound on humans

For several years, citizens have complained about increasing annoyance by infrasound - a sound, which is actually below the normal hearing threshold. Results of a study of the German Federal Environment Agency (UBA) deliver scientific knowledge and insight into this subject.
This feasibility study evaluated the state of knowledge about the effects of infrasound on human beings, the identification of infrasound sources and the potential concernments in Germany due to infrasound. Furthermore, a study design was developed for a noise impact study concerning infrasound immissions.Based on these findings, recommendations for the further development of regulations on immission control were made. For further information please see: l
http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_40_2014_machbarkeitsstudie_zu_wirkungen_von_infraschall.pdf

"The embeddedness of inclusionary housing in planning and housing systems: insights from an international comparison"

A special issue of the Journal of Housing and the Built Environment (Volume 29, Issue 3, September 2014) deals with the question on how and in which way a country, through its public policy, can stimulate the provision of social or affordable housing. Hereby, the authors tackle the question, how land is made available for building social housing, at prices below the unconstrained market price for such land in such locations, how the social housing which is built is not segregated but integrated with other uses, and how the arising costs may be subsidesed. 12 articles show several examples from all around the world.
Further information: http://link.springer.com/journal/10901/29/3/page/1

NCHH and APHA Release the National Healthy Housing Standard

The American Public Health Association (APHA) and the National Center for Healthy Housing (NCHH) released a new national healthy housing standard in May. The *National Healthy Housing Standard* defines livable housing conditions and targets the 30 million U.S. families who live in unsafe residences. It is intended to be used by government agencies and property owners to ensure that the nation's housing stock is adequately maintained and protects the health and safety of residents.
Further Information: National Healthy Housing Standard

Literature

In this section we will provide a collection of recent housing and health publications from a variety of backgrounds. Literature published in German or French, respectively, is indicated with the German flag or the French flag.

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Allergies and Respiratory Diseases

Phosphorus flame retardants in indoor dust and their relation to asthma and allergies of inhabitants.
Araki A, Saito I, Kanazawa A, Morimoto K, Nakayama K, Shibata E, Tanaka M, Takigawa T, Yoshimura T, Chikara H, Saijo Y, Kishi R.
Indoor Air. 2014 Feb;24(1):3-15.

Reducing patients' exposures to asthma and allergy triggers in their homes: an evaluation of effectiveness of grades of forced air ventilation filters.
Brown KW, Minegishi T, Allen JG, McCarthy JF, Spengler JD, MacIntosh DL.
J Asthma. 2014 Aug;51(6):585-94.

Indoor environmental factors associated with wheezing illness and asthma in South Korean children: phase III of the International Study of Asthma and Allergies in Childhood.
Chae Y, Hahm MI, Ahn K, Kim J, Kim WK, Lee SY, Park YM, Han MY, Lee KJ, Kwon HJ.
J Asthma. 2014 Jul 11:1-7. [Epub ahead of print]

Early-life residential exposure to soil components in rural areas and childhood respiratory health and allergy.
Devereux G, Tagiyeva N, Turner SW, Ayres JG, Seaton A, Hudson G, Hough RL, Campbell CD, Shand CA.
Sci Total Environ. 2014 Jan 1;466-467:338-44.

A cross-sectional analysis of pet-specific immunoglobulin E sensitization and allergic symptomatology and household pet keeping in a birth cohort population.
Ezell JM, Wegienka G, Havstad S, Ownby DR, Johnson CC, Zoratti EM.
Allergy Asthma Proc. 2013 Nov-Dec;34(6):504-10.

Mites and allergy.
Fernández-Caldas E, Puerta L, Caraballo L.
Chem Immunol Allergy. 2014;100:234-42.

The indoor environment and inner-city childhood asthma.
Kanchongkittiphon W, Gaffin JM, Phipatanakul W.
Asian Pac J Allergy Immunol. 2014 Jun;32(2):103-10. *Review.* *Free Article.*

Allergens on desktop surfaces in preschools and elementary schools of urban children with asthma.
Kanchongkittiphon W[1], Sheehan WJ, Friedlander J, Chapman MD, King EM, Martirosyan K, Baxi SN, Permaul P, Gaffin JM, Kopel L, Bailey A, Fu C, Petty CR, Gold DR, Phipatanakul W.
Allergy. 2014 Jul;69(7):960-3.

Quantity and diversity of environmental microbial exposure and development of asthma: a birth cohort study.
Karvonen AM, Hyvärinen A, Rintala H, Korppi M, Täubel M, Doekes G, Gehring U, Renz H, Pfefferle PI, Genuneit J, Keski-Nisula L, Remes S, Lampi J, von Mutius E, Pekkanen J.
Allergy. 2014 Aug;69(8):1092-101.

Effects of long-term exposure to PM10 and NO2 on asthma and wheeze in a prospective birth cohort.
Mölter A, Agius R, de Vocht F, Lindley S, Gerrard W, Custovic A, Simpson A.
J Epidemiol Community Health. 2014 Jan;68(1):21-8.

Indoor Air

Clustering cities with similar fine particulate matter exposure characteristics based on residential infiltration and in-vehicle commuting factors.
Baxter LK, Sacks JD.
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Characterization of polycyclic aromatic hydrocarbons in emissions of different mosquito coils.
Dubey J, Banerjee A, Meena RK, Kumari KM, Lakhani A.
Bull Environ Contam Toxicol. 2014 Jun;92(6):650-4.

Public health and components of particulate matter: the changing assessment of black carbon.
Grahame TJ, Klemm R, Schlesinger RB.
J Air Waste Manag Assoc. 2014 Jun;64(6):620-60. *Review.*

Surface dust wipes are the best predictors of blood leads in young children with elevated blood lead levels.
Gulson B, Anderson P, Taylor A.
Environ Res. 2013 Oct;126:171-8.

Home kitchen ventilation, cooking fuels, and lung cancer risk in a prospective cohort of never smoking women in Shanghai, China.
Kim C, Gao YT, Xiang YB, Barone-Adesi F, Zhang Y, Hosgood HD, Ma S, Shu XO, Ji BT, Chow WH, Seow WJ, Bassig B, Cai Q, Zheng W, Rothman N, Lan Q.
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Associations between bacterial communities of house dust and infant gut.
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Environ Res. 2014 May;131:25-30.

Phthalate metabolites in urine samples from Danish children and correlations with phthalates in dust samples from their homes and daycare centers.
Langer S, Bekö G, Weschler CJ, Brive LM, Toftum J, Callesen M, Clausen G.
Int J Hyg Environ Health. 2014 Jan;217(1):78-87.

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Lim YW, Kim HH, Lee CS, Shin DC, Chang YS, Yang JY.
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Runeson-Broberg R, Norbäck D.
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Shinohara N, Tokumura M, Kazama M, Yonemoto Y, Yoshioka M, Kagi N, Hasegawa K, Yoshino H, Yanagi U.
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Whitehead TP, Metayer C, Ward MH, Colt JS, Gunier RB, Deziel NC, Rappaport SM, Buffler PA.
Am J Public Health. 2014 Jul;104(7):1320-6.

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Gemeinsame Mitteilung der Arbeitsgruppe Luftanalysen der Ständigen Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe der Deutschen Forschungsgemeinschaft und der Ad-hoc-Arbeitsgruppe Innenraumrichtwerte der Obersten Landesgesundheitsbehörden.
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Effects of water-damaged homes after flooding: health status of the residents and the environmental risk factors.
Azuma K, Ikeda K, Kagi N, Yanagi U, Hasegawa K, Osawa H.
Int J Environ Health Res. 2014 Apr;24(2):158-75.

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Jung KH, Liu B, Lovinsky-Desir S, Yan B, Camann D, Sjodin A, Li Z, Perera F, Kinney P, Chillrud S, Miller RL.
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Marsden-Haug N, Hill H, Litvintseva AP, Engelthaler DM, Driebe EM, Roe CC, Ralston C, Hurst S, Goldoft M, Gade L, Wohrle R, Thompson GR, Brandt ME, Chiller T; Centers for Disease Control and Prevention (CDC).
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Méheust D, Le Cann P, Reboux G, Millon L, Gangneux JP.
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Seo S, Choung JT, Chen BT, Lindsley WG, Kim KY.
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Ward MD, Copeland LB, Lehmann J, Doerfler DL, Vesper SJ.
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Events Announcement

35th AIVC Conference - Air Infiltration and Ventilation
September 24-25, 2014
Poznan, Poland
Further Information: | AIVC

8th Conference on moulds 2014
8. Schimmelpilzkonferenz 2014
September 25-26, 2014
Nuremberg, Germany
Further Information: Conference on moulds 2014

9th German Conference on Allergies
9. Deutscher Allergiekongress
October 2-4, 2014
Wiesbaden, Germany
Further Information: Allergiekongress

Microbiology and Infection 2014
4th Joint Conference of the German Society for Hygiene and Microbiology (DGHM) and the Association for General and Applied Microbiology (VAAM)
October 5-8, 2014
Dresden, Germany
Further Information: dghm-vaam-kongress.de

24th Conference of the International Society of Exposure Science ISES
October 12-16, 2014
Cincinnati / Ohio, USA
Further Information: International Society of Exposure Science (ISES)

Indoor Radon Workshop
October 2014 (exact date still to be defined)
Ispra / Italy
Further Information: Indoor Radon Workshop - JRC Science Hub - European Commission

Word Building Congress 2014
October 28-30, 2014
Barcelona, Spain
Further Information: World Building Congress 2014

BAU 2015 - World's Leading Trade Fair for Architecture, Materials and Systems
January 19-24, 2015
Munich, Germany
Further Information: BAU – World's Leading Trade Fair for Architecture, Materials, Systems

ICAPC 2015 - International Conference on Air Pollution and Control
February 23-24, 2014
Paris, France
Further Information: ICAPC Paris 2015: International Conference on Air Pollution and Control

ASHARE 2015 Annual Conference
June 27- July 1, 2015
Atlanta, USA
Further Information: Indoor Environment Connections

13th Word Allergy Congress 2015
October 14-17, 2015
Seoul, Korea
Further Information: World Allergy Congress

9th National Housing Conference
October 28-30, 2015
Perth, Australia
Further Information: NHC - National Housing Conference

2015 Greenbuild International Conference and Expo
November 18-22, 2014
Washington D.C., USA
Further Information: 2015 Greenbuild International Conference and Expo

Nanotechnology based sensors and detection methods - workshop
December 1-2, 2014
Ispra, Italy
Further Information: Nanotechnology based sensors and detection methods - workshop - JRC Science Hub - European Commission

Message Board

In this section we will inform you about activities and projects related to housing and health that are being carried out by WHO or the WHO CC. This may relate to ongoing activities and projects, as well as invitations to participate in data collections or case study projects.

WHO work on indoor, built and urban environments

International lead poisoning prevention: Week of action

The second International Lead poisoning prevention week of action will take place on 19–25 October 2014, with the elimination of lead paint as the theme. Activities in over 100 cities took place last year, in 44 countries, and the aim is to double this number this year. If you, or any-one you know, is organizing a lead-poisoning prevention event during the action week please register it on the WHO website http://www.who.int/ipcs/lead_campaign/event_registration/en/. A multilingual set of campaign materials that can be adapted for local use can be found at http://www.who.int/ipcs/lead_campaign/en/. There is also a link to the summary report of last year's campaign. The week of action is an initiative of the Global Alliance to Eliminate Lead Paint (GAELP), for which WHO and UNEP provide the secretariat.

For more information about GAELP, please click here.

Re-inventing the toilet for 2.5 billion people

In a bid to make sanitation for all a global development priority, the UN General Assembly has designated November 19th as World Toilet Day (for further details, please go to http://www.who.int/pmnch/media/events/2014/wtd/en/). A recent issue of the WHO Bulletin highlighted efforts to design high-technology, low-cost toilets for the 2.5 billion people currently lacking access to basic sanitation infrastructure. Lack of access to improved sanitation facilities disproportionally affects the poor, putting them at increased risk for diseases such as cholera, typhoid, dysentery and trachoma.

To read the full article in the WHO Bulletin, click
http://www.who.int/bulletin/volumes/92/7/14-020714.pdf

Floods and health - Fact sheets for health professionals

Over recent decades an increasing trend in frequency and intensity of heavy precipitation events has been observed across the WHO European Region. High precipitation extremes can result in flash floods, river floods, drinking water supply and sewage system failure, landslides and mudslides. They can initiate devastating floods, which affect large areas and are of long duration. Floods affect human health through many pathways, and health professionals can take numerous measures to protect the health of affected populations.

A series of fact sheets has been developed, targeted at ministries of health; national, regional and local health authorities; and medical and public health professionals. These fact sheets describe in short what to do in case of a flood, in the absence of a fully functional flood health preparedness and response plan. Various fact sheets refer to issues related to buildings and building systems, such as mould clean-up, chemical hazards or water, sanitation and hygiene.

The report with all fact sheets can be accessed at

http://www.euro.who.int/__data/assets/pdf_file/0016/252601/Floods-and-health-Fact-sheets-for-health-professionals.pdf?ua=1

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