hús&heilsa

Anne Hyvarinen - fyrirlestur

Heilnæm hús; hlutverk og samvinna mismunandi fagstétta

Sylgja Dögg Sigurjónsdóttir

B.Sc. Líffræði, meistaranemi í lýðheilsuvísindum HÍ (MPH).

20.11.2013

Anne Hyvarinen

- Ritari ISIAQ
  - IceIAQ deild á Íslandi
- Starfar hjá ”National Institute of Health and Welfare” í Kuopio í Finnlandi.
- Phd gráða í náttúru- og umhverfisvísindum
- 150 birtar greinar, rannsóknir í Finnlandi

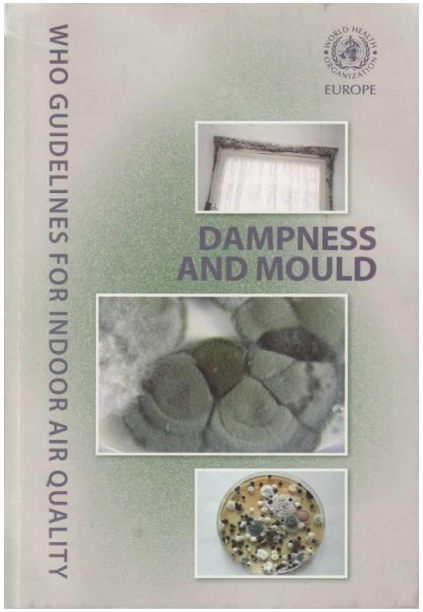
Rakaskemmdir og raki, leiða til örveruvaxtar

- Raki, eini takmarkandi þátturinn á vöxt.
- Í þessu umhverfi vaxa örverur sem gefa frá sér agnir sem berast í inniloft:
  - Gró, MVOC, eiturefni, svepphlutar og aðrar smærri agnir.
- Þurr byggingarefni þar sem örverur hafa náð að vaxa upp geta líka valdið skaða:
  - Eiturefni og ofnæmisvakar eru mjög stöðug í innilofti og lífrænt ryk er alltaf álitið mögulega skaðlegt heilsu.

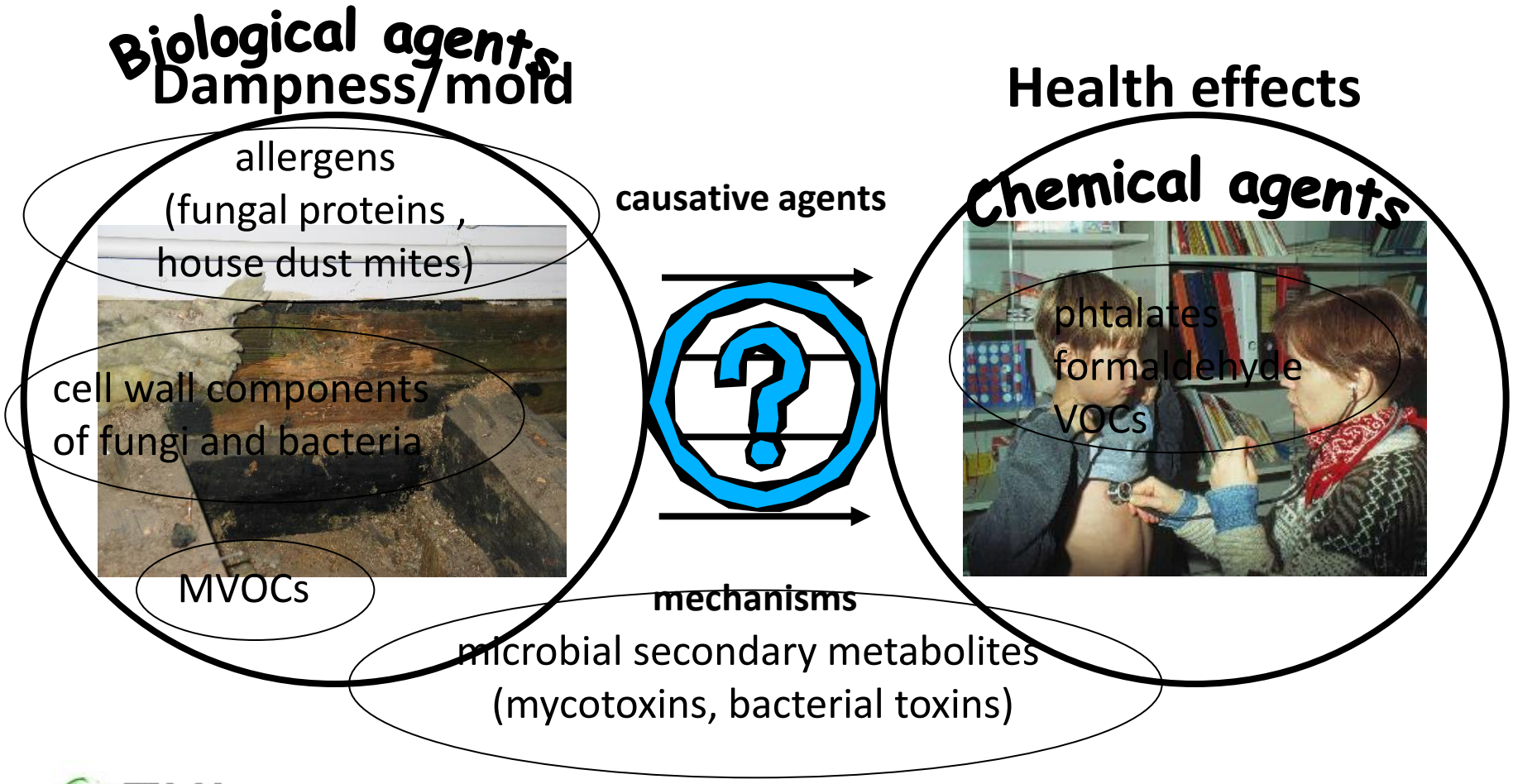
Er þetta raunveruleg ógn við heilsu?

- Samkvæmt WHO frá 2009 & samantekt Mendell (EHP, 2011) er raki og mygla áhættuþáttur fyrir heilsu.
  - No causality (association and other evidence)
  - **Sufficient epidemiological evidence of increased**
    - Upper respiratory track symptoms (cough, wheezing, dyspnea)
    - Respiratory infections
    - Exacerbation and development of asthma
    - Bronchitis
    - Allergic rhinitis

- Árið 2011 gáfu út gögn um Evrópu
  - 18% (5-37%) af íbúum Evrópu útsett fyrir raka.



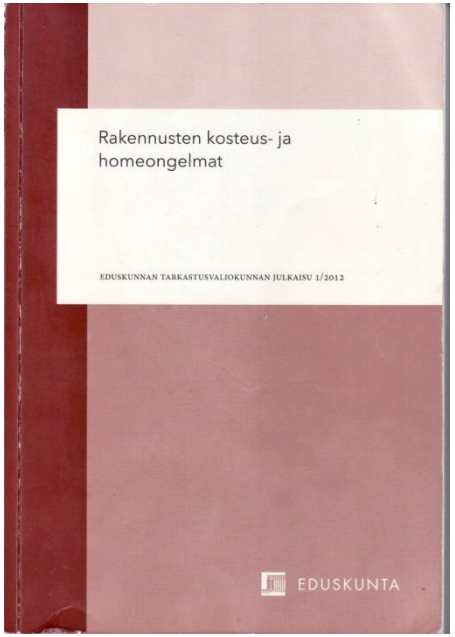
Dampness related indoor pollutants - potential causative agents of adverse health effects



Tíðni rakavandamála í Finnlandi

1.45 milljón byggingar: 85% heimili, 15% annað

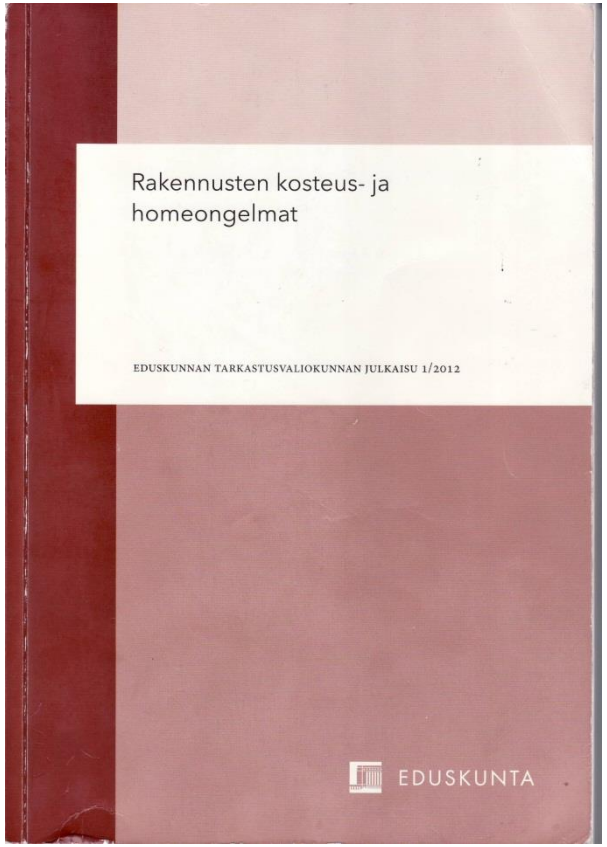
Building type	Observed (several ref.)	Estimated to be significant (Reijula *et al.* 2012)
Single family and detached apartments	55% (80%)	7-10%
Apartment buidings	42-43%	6-9%
Schools and day care centers	10-60%	12-18%



Economial importance of moisture damage in Finland (Reijula *et al.* 2012)

Economial importance of moisture damage in Finland (Reijula *et al.* 2012)

- Renovation of buildings with significant moisture damage would cost on one time basis 1.2-1.6 billion € (
- Costs of moisture and mold damage related to health 23-953 million €
  - Includes costs for symptoms, diseases, their diagnosis, loss of capability of work and decrease in work efficiency
- http://web.eduskunta.fi/dman/Document.phx?documentId=er28612160849612 (summary in swedish and english)



Finnland

- Finnland: Kostnaður við lagfæringar €10-40.000 eða 1,5-6 milljónir ISK í hverju tilfelli (Tao Lu, Xiaoshu Lu og Marttti Viljanen, 2011)
  - Kostnaður 1,2-1,6 miljarðar evra að laga allt sem þarf að laga núna.
- Kostnaður vegna mygluvandamála Finnlandi (5,2milljónir íbúa)
  - 23-953 milljónir evra
  - Dæmi: 450 milljón evra á ári umreiknað m.v. Ísland rúmlega 4,7 milljarðar ISK
  - (skýrsla vinnueftirlits Finnlands 2012)
  - Tæplega 20% íbúa verða fyrir heilsuspillandi áhrifum af raka og myglu.
  - Helstu rannsóknir eru frá Finnlandi
    - Ný rannsókn september 2012 um áhrif myglusveppaeiturs ákveðinnar tegundar (mycotoxin) á samskipti fruma í taugakerfi og öndunarvegi (Raimo Mikkola, 2012)
    - Meðferð sjúklinga felst í því að ,,**lækna**“ umhverfið

Endurbætur á byggingum eftir raka- og mygluvandamál og heilsufar

(Cochrane review, Sauni *et al*. 2011)

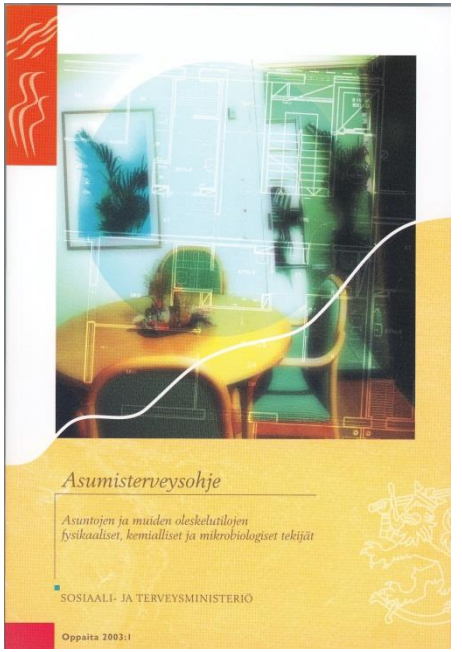
- Tilgangur rannsóknar að kanna árangur endurbóta á byggingum til að minnka einkenni frá öndunarvegi, sýkingar og asthma.

- Eingöngu 8 rannsóknir sem komust í úrtakið
  - Kröfur: Selection criteria: randomised controlled trials (RCT), cluster-RCT, interrupted time series studies adn controlled before-after (CBA) studies

Remediating of buidings damaged by dampness and mould and health outcomes (Cochrane review, Sauni *et al.* 2011)

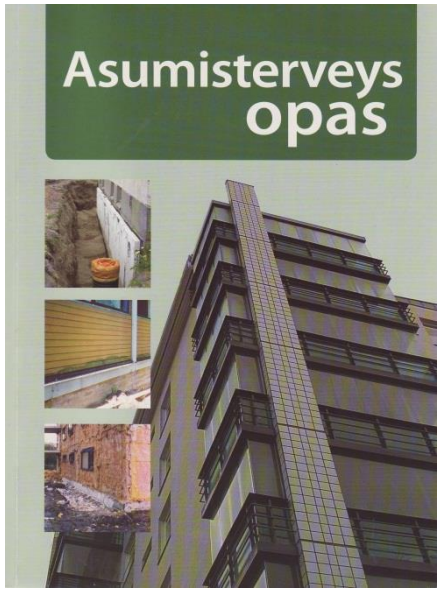
- Reasonable scientific evidence
  - Among adults, decrease in respiratory symptoms and infections
  - Among children, decrease in hospital admissions, but not in symptom days
- School studies usually before-after (CBA)
  - =>Weaker evidence
  - No evidence of decrease in respiratory symptoms
  - Doctor's visit due to common flue possibly decreased
- More and better research is needed

Guidance for mold problems - examples



- WHO guidelines (2009): General recommendations - detailed guidelines on national level
- FINLAND:
- Guideline for healthy housing (2003)
- Handbook for healthy housing (2009)
- Handbook for resolving moisture and mold damage in schools (2008)
- Handbook for renovating moldy schools
- Recommendations for clinicians (2007)
- Recommendations for clean up of building and furniture after renovations (2012)

Etc.



THL

NATIONAL INSTITUTE FOR HEALTH AND WELFARE, FINLAND

Health protection act in Finland

- Protective - a circumstance that may cause health effects is considered as a potential health hazard and should be removed

- Moisture and mold damage are considered as such circumstances

Main philosophy of the finnish guidelines for microbes

- Microbial growth in building is a potential health hazard – also dried growth
- Moisture and mold damage should be repaired and causes that lead to damage should be removed
- To give guidance on
  - How to measure microbial growth and contamination
  - What is normal in the indoor air of homes in northern climate
  - What kind of indoor air findings indicate abnormal source or contamintion
  - What kind of findings indicate microbial growth on surfaces or building material
- Not health based guidelines!

Detection of mold damage ”in short”

- Review of existing information
- Visible microbial growth is a health hazard – no microbial measurements are needed
  - Minor mold spots in bad room – increase ventilation, cleaning
- Moisture problems suspected, smell of mold
  - **Technical investigation of the building**
  - Building material and surface samples from suspected sites
    - Observation of risk structures important!
    - Opening structures often needed!
- Air sampling, only if other methods have shown nothing, but mold damage is suspected due to symptoms

Sýnatökur (Finnland)

Loftsýni

- Vafasöm, gefa ekki rétta mynd af ástandi
  - Þarf mörg endurtekin sýni á sama stað
  - Segir ekki til um ástand, geta gefið vísbendingar en aldrei staðsett
  - Oftast óþarfar en ef ekkert finnst við sjónræna skoðun

Yfirborðssýni og sýni af byggingarefnum

Er mygluvöxtur?

Ef myglan er þurr – getur gefið falskt neikvætt ef sýnið er ræktað upp.

Examples of sources of microbes; and *factors affecting* I

- Outdoor; *climate*, *season, ventilation*
- House dust, microcolonies; *RH, activity*
- Housekeeping, food stuff, cooking; *”cleaniness level”, ventilation*
- Firewood, other biological material; *storage, handling*
- Pets, their litter and food, clothes used eg. barns

THL

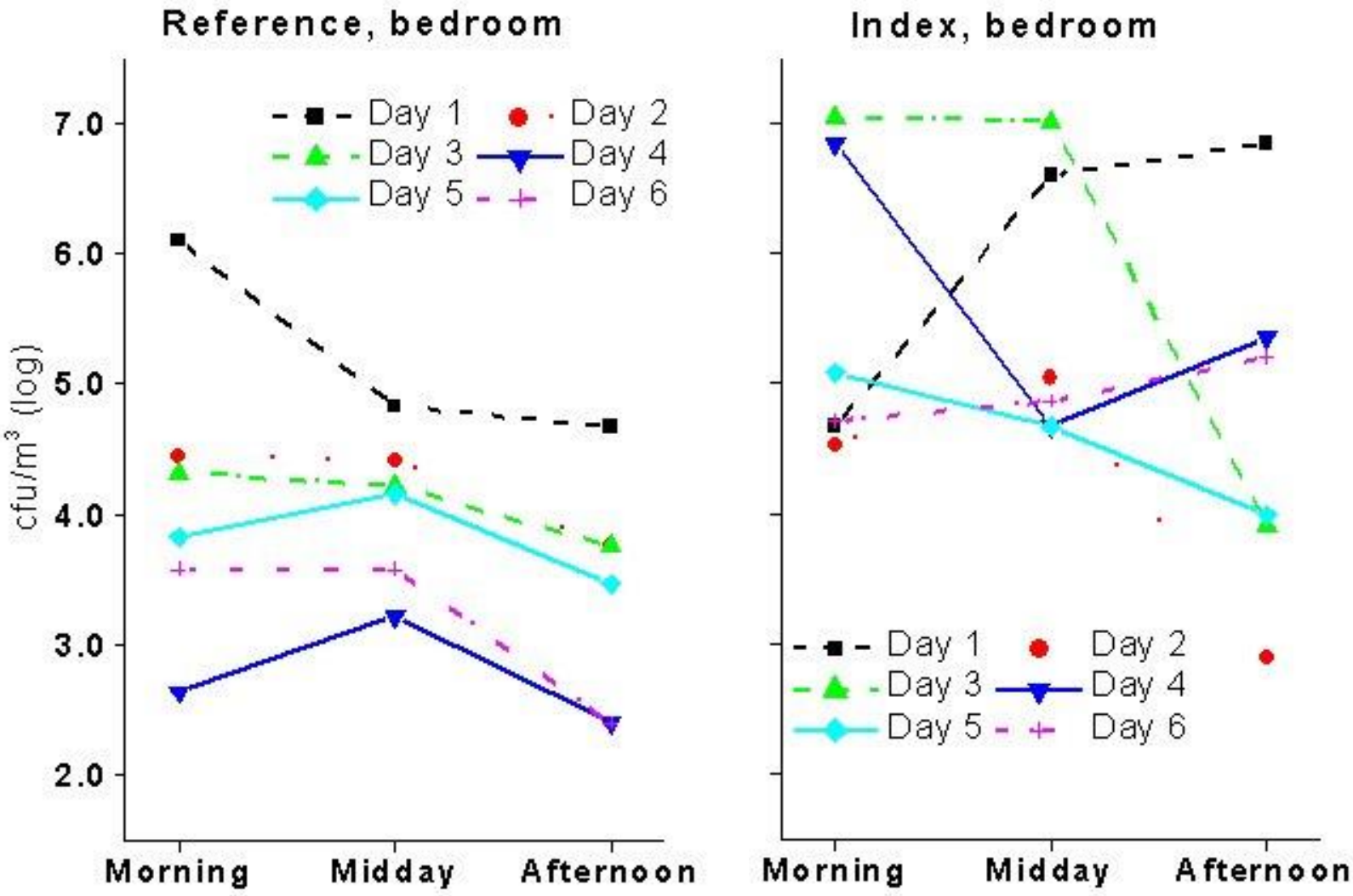
NATIONAL INSTITUTE FOR HEALTH AND WELFARE, FINLAND

Examples of sources of microbes; and *factors affecting* II

- Cellars, attics etc; *ventilation, air pressure conditions*
- *Age and structure of buildings*
- Farming buildings; *changing of clothes, distance*
- Mouldy structures; *severity, extend, age, location, air pressure conditions, tightness of structures*

THL

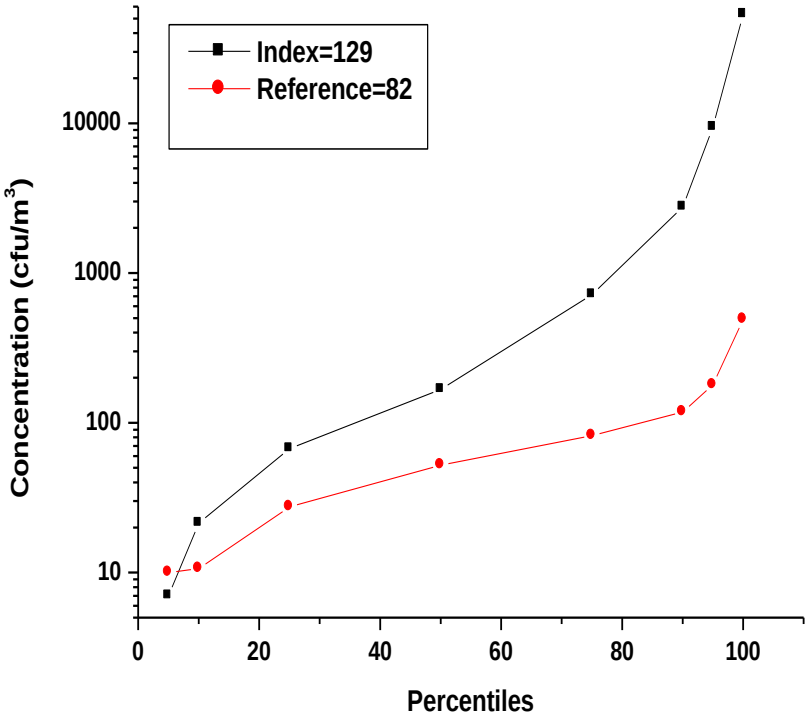
NATIONAL INSTITUTE FOR HEALTH AND WELFARE, FINLAND



Hyvärinen *et al.* 2001

Sampling campaings needed (Hyvärinen *et al*. 2001)

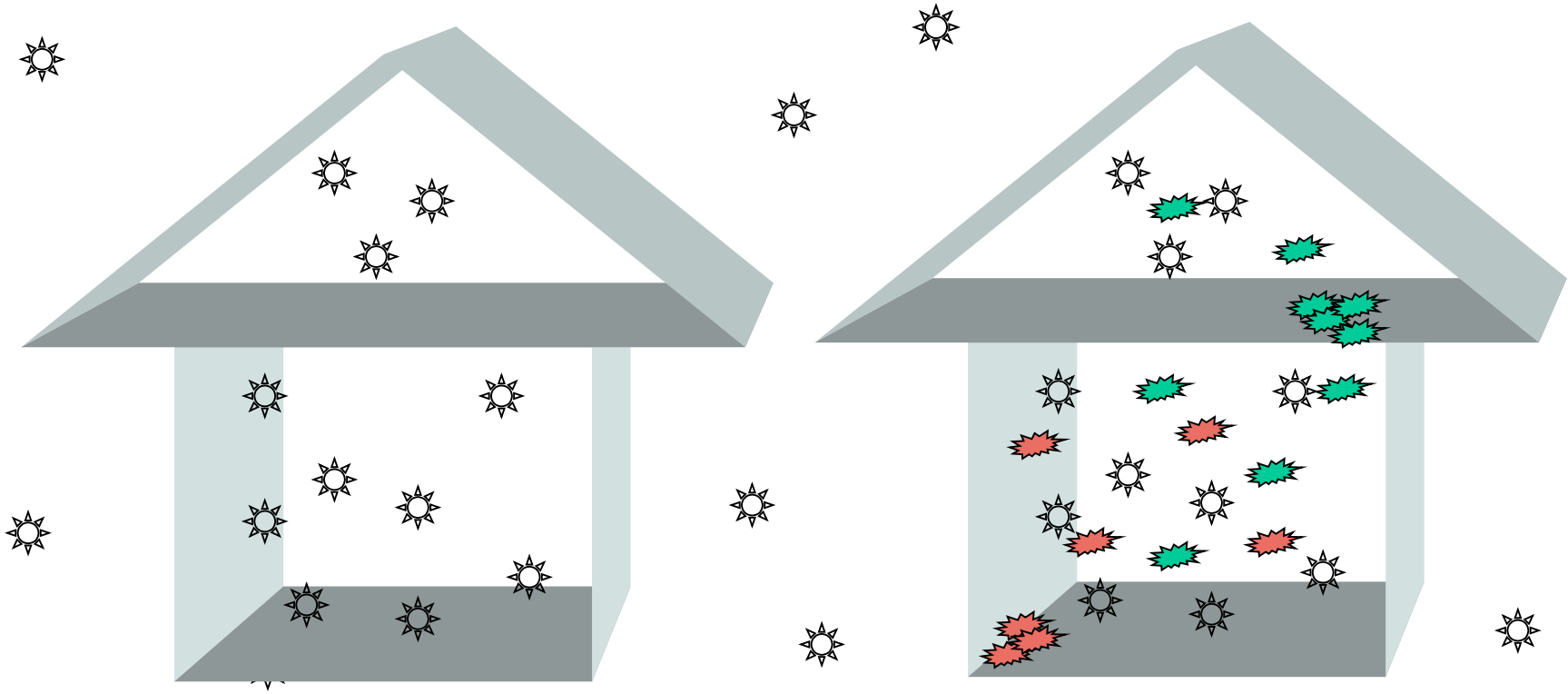
- Concentrations higher in damaged homes (figure)
- One sample is not enough to characterize the overall airborne fungal concentration of a residence
- A single negative result do not exclude the possibility of mold damage!!!!
- Several samples and samplings needed
- ”If lucky” a few samples can show abnormal condition → actions to locate the damage



THL

NATIONAL INSTITUTE FOR HEALTH AND WELFARE, FINLAND

How does the indoor air of a moisture-damaged house differ from normal?
(in winter in Finland)



Concentration

usually < 100 cfu/m^3 ☼ often > 100 cfu/m^3

THL

NATIONAL INSTITUTE FOR HEALTH AND WELFARE, FINLAND

Microbial volatile organic compounds MVOCs

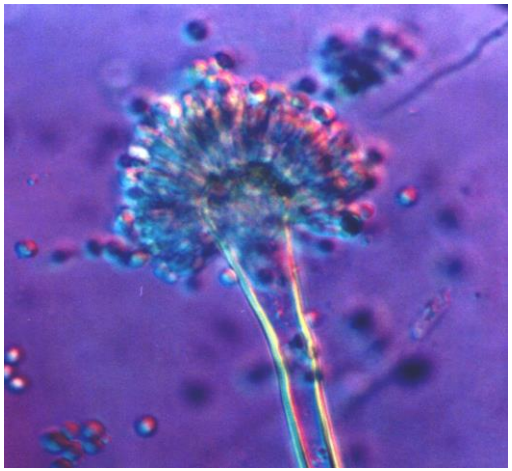
- secondary metabolites produced by microbes during growth and proliferation (i.e. associated with active growth)
- eg. alcohols, ketones and aldehydes
- 100 -200 different; ”smell of mold”, ”smell of cellar”
- however, most of these compounds do have also other source (eg. volatiles released from building materials)
- Should **NOT** be used in detecting/concluding on moisture and mold damage
- Note: MVOC index proposed for mold detection

General toxicity assays

- basis: microbial growth can be toxic via production of toxic metabolites
- measurement of general toxiticy in sample materials (≠ toxin determination); assessed from air or settled dust
- typically done in different cell culture or bioassay systems
- the result does not reveal the origin of the toxicity and whether its related to microbes (can also derive from outdoor air pollution, combustion, paints, household products, ...)
- Different approaches tested in U of Eastern Finland, THL, TTL, U of Helsinki and U of Turku
  - Conclusion: Toxicity measured from dust **cannot** distinguish moldy homes with symptomatic occupants from non-moldy homes without symptomatic occupants

Detection of mold problems - summary

- No method superior for mold detection
- Combination of technical, microbial and health studies are needed to achieve an overall understanding of the problem and the measures needed
- New methods need to be validated and interpretation guidelines should be established to ensure uniform practises
  - International collaboration in developing guidelines would be essential
- Clinical tools largely missing



Propability of Exposure (Finnish Ministry for Social Affairs and Health 2009)

- Unlikely
  - No moisture damage, no risk structures, room not strongly under pressured, no air leakage from abnormal microbial sources
- Potential
  - Signs of moisture damage, risk structures, repaired moisture damage, rooms occasionally strongly under pressured and/or potential air leakage from abnormal microbial sources
- Propable
  - Visible damage, microbial growth in surfaces or surrounding building structures, abnormal microbial concentrations observed, rooms strongly under pressured and/or air leakage from damaged room or structure

Remediation – simple and complex

- Main principle of remediation: cessation and prevention of exposure
- Remove the mold, repair the water damage,
- (often) improve ventilation
- Mold remediation usually does good for the building, not only its occupants
- Each building and its moisture damage is an individual;
  - Difficult to design the repairs
  - Unpleasant surprises may occur when dismantled
  - guidelines available (eg. RATU-cards, Ministry of Environment (YM-hometalkoot))

Remediation: eliminate exposure

- Eliminate exposure, prevent contamination
- During dismantling and renovation, specific risks
- Evacuate the occupants if possible
- Use personal protection!
- Isolate the remediation area carefully!
  - Temporary walls, local exhaust

General principles for mold remediation

- Find out the cause of water intrusion, repair fault
- Prevent the renewal of damage
- Remove damaged materials
  - Microbial growth and mycelium must be physically removed
  - Mechanical removal of surface material of structures hard to be removed
  - Drying not enough and disinfection no solution
    - Efficient biocides also harmful for humans
    - Biocides not so efficient on fungi, spores
    - Biocides may change the composition of microbes, increase toxin production
    - Even ”dead” mycelium contains toxins, allergens…
- Encapsulation
  - only when materials cannot be removed or cleaned
  - Challenging!

Examples of actions and initiatives to resolve the problem

- ”Moisture and mold problem initiative” –program funded by government for 4 years now, examples of activities
  - Coordinating eg. training and recommendations (clean up procedures after remidiation, usage of mold dog, how to clean moldy structures that cannot be removed etc., etc.)
  - Web-site eg. examples of critical structures of different types of houses http://www.hometalkoot.fi/sv and news http://uutiset.hometalkoot.fi/sv/hem.html
  - TV-serie to inform people about moisture damage, to visit the website
- Partial funding can be applied for repairs of private houses
- Governmental funding for repairs of moldy schools – only cases with thorough building investigation and repair plans will be funded
- Certifications of qualification for buiding investigations, repair planning etc. will be established

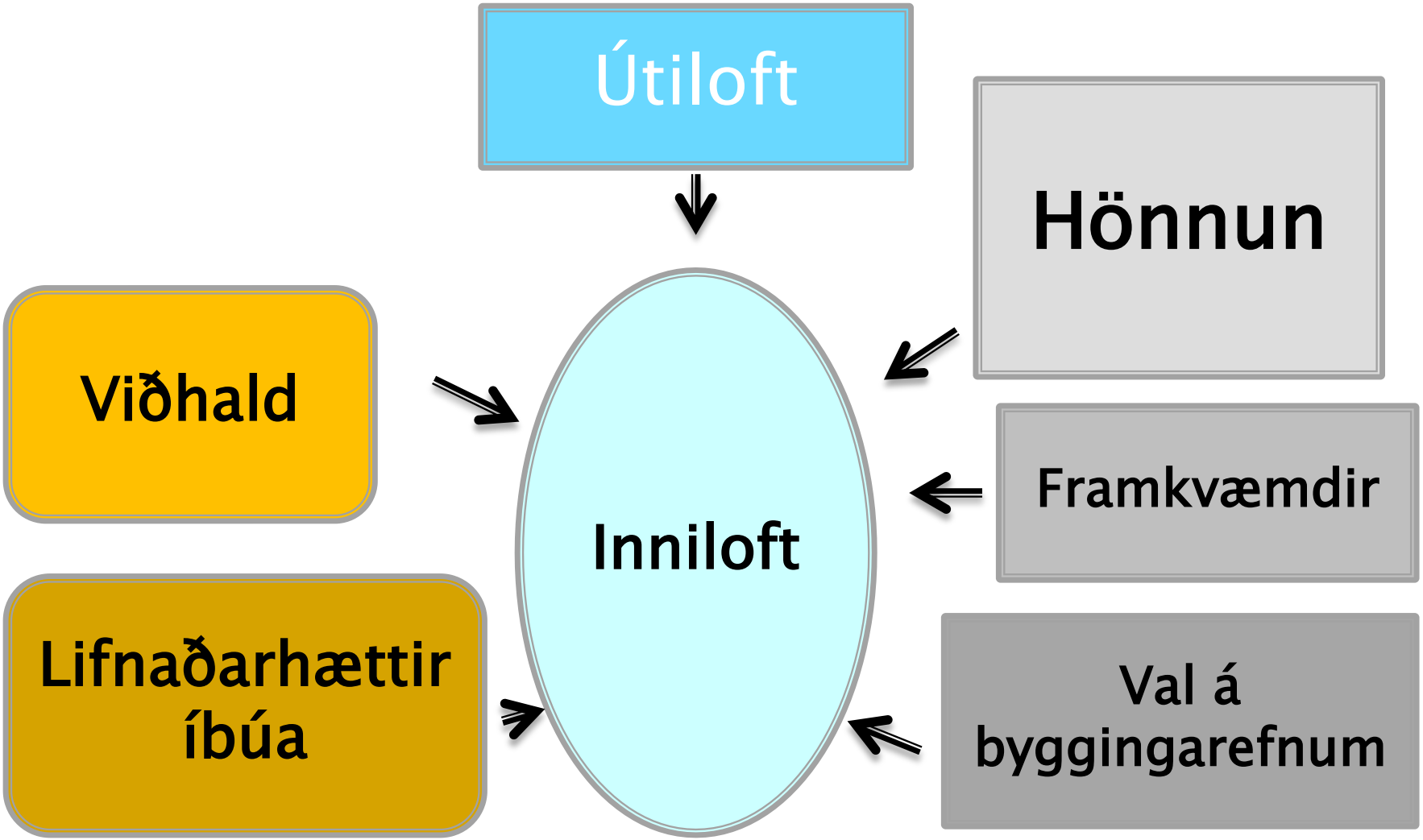
Sjúkdómar

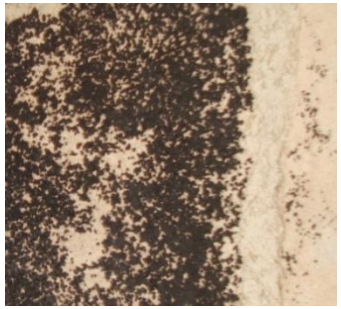
= flókið samspil erfða og umhverfis

⇨ **INNILOFT** okkar helsti umhverfisþáttur

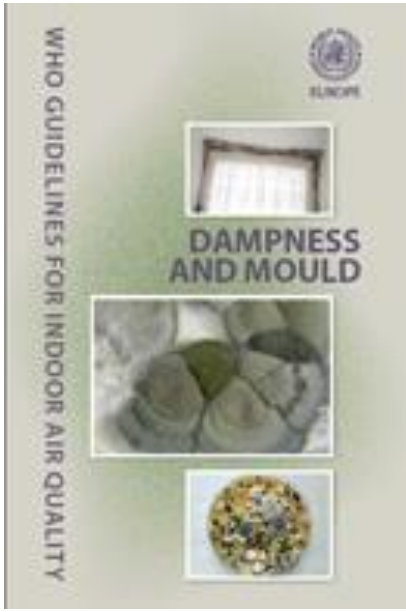
90 % innandyra

Inniloft – áhrifaþættir





WHO



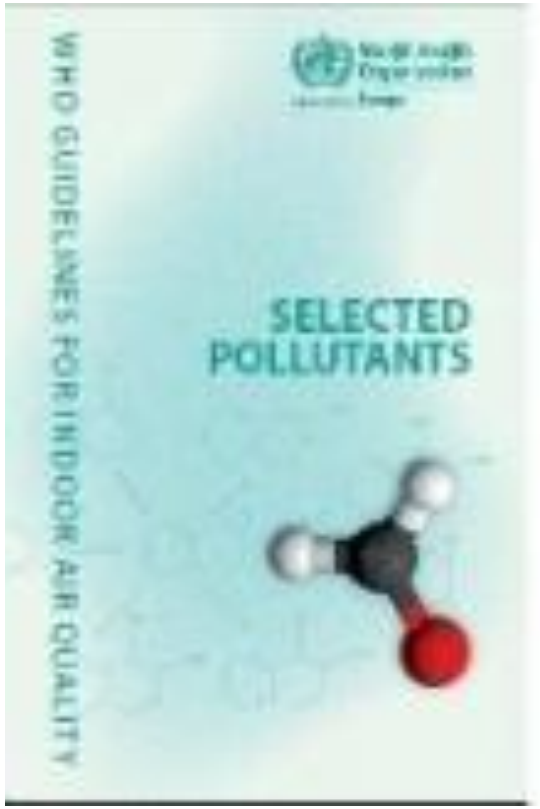
- Leiðarvísir WHO frá 2009:
- Raki og mygla er áhættuþáttur heilsu
- **Mikilvægt að stöðva rakaupptök og *FJARLÆGJA* mygluð/rök byggingarefni.**
  - Eiturefni og úðun er **EKKI** lausnin.
  - Skyndilausnir duga ekki – fjarlægja þarf myglu og afleiðingar raka.
  - Verkferlar skipta máli til þess að ná árangri.

WHO, 2009. Guidelines for indoor air quality: dampness and mould

WHO – desember 2010

- Skýrsla um efni sem hafa áhrif á loftgæði innandyra – viðmiðunarmörk.

- Krabbameinsvaldandi, innkirtlar ofl.
  - Þalöt – PVC vinyl dúkar – einhverfa?
    - Um 6 af hverjum 1000 börnum
  - Napthalane
  - Nitrogen dioxide
  - Polycyclic aromatic hydrocarbons
  - Radon
  - Benzene – Vinyldúkar, gólfefni, nylon teppi, málningu, límefnum ofl.
    - Í hreinsiefnum
    - Hátt hlutfall í bílskúrum
    - Gas við matseld



Formaldehýð

Getur tekið nokkra mánuði að ,,loftast út“

Byggingarefni eins og spónaplötur

Límefni, lökk, málning ofl.

Hreinsivörur: mýkingarefni, sótthreinsiefni

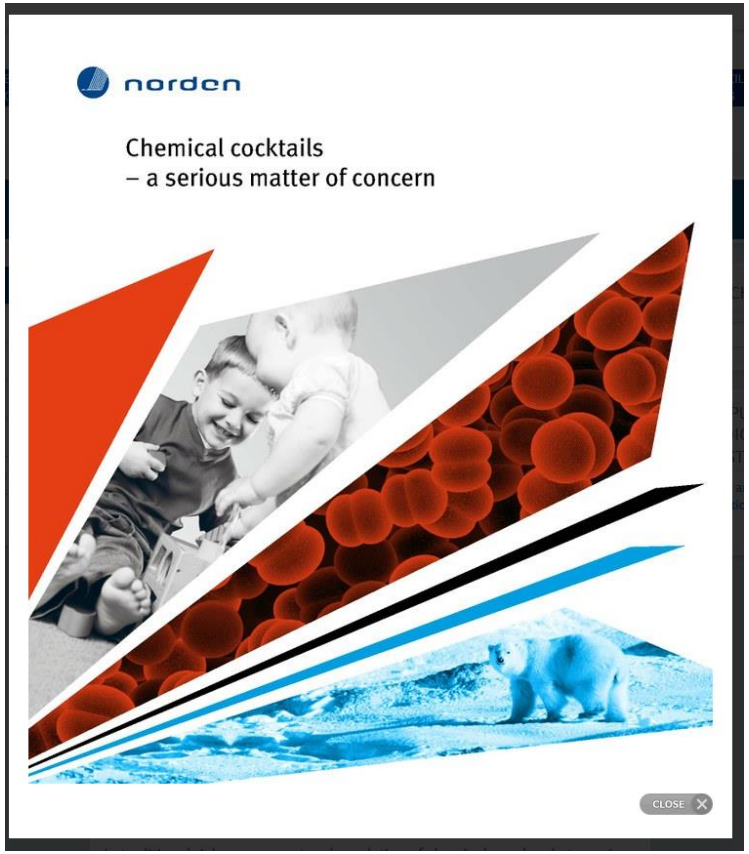
- Formaldehýð hærra í inni-lofti þar sem eru timburhús-gögn og innréttingar,
- (Viegas e Prista, 2008).

Kokteiláhrif – efna

- Haust 2010 Norræna ráðherranefndin gefur út skýrslu.

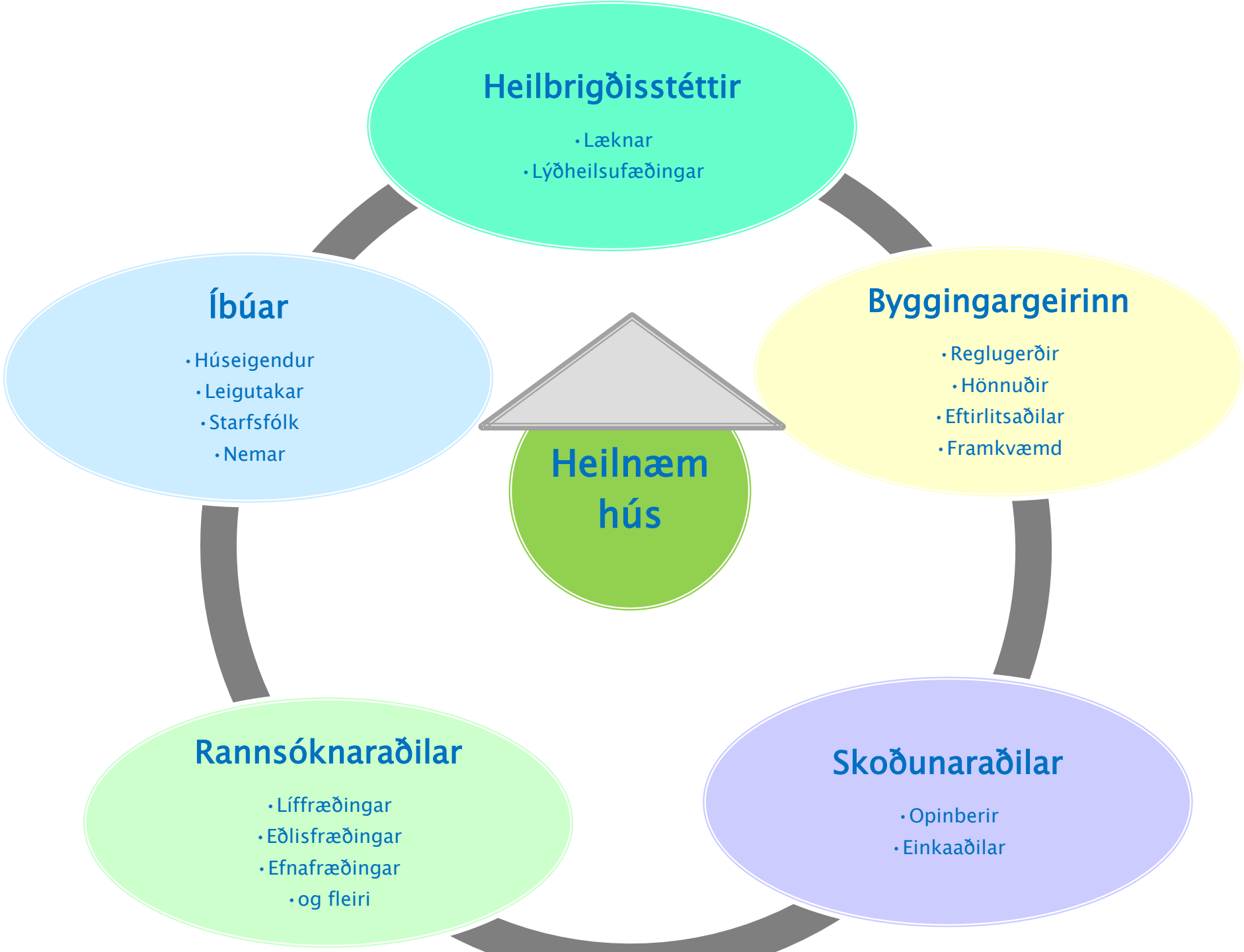
- 3. júní 2012 – skýrsla EU Evrópuráð
  - Efni sem geta verið skaðlaus ein og sér – geta orðið hættuleg með öðrum efnum.

  - Viðmiðunarmörk gilda því ekki lengur.

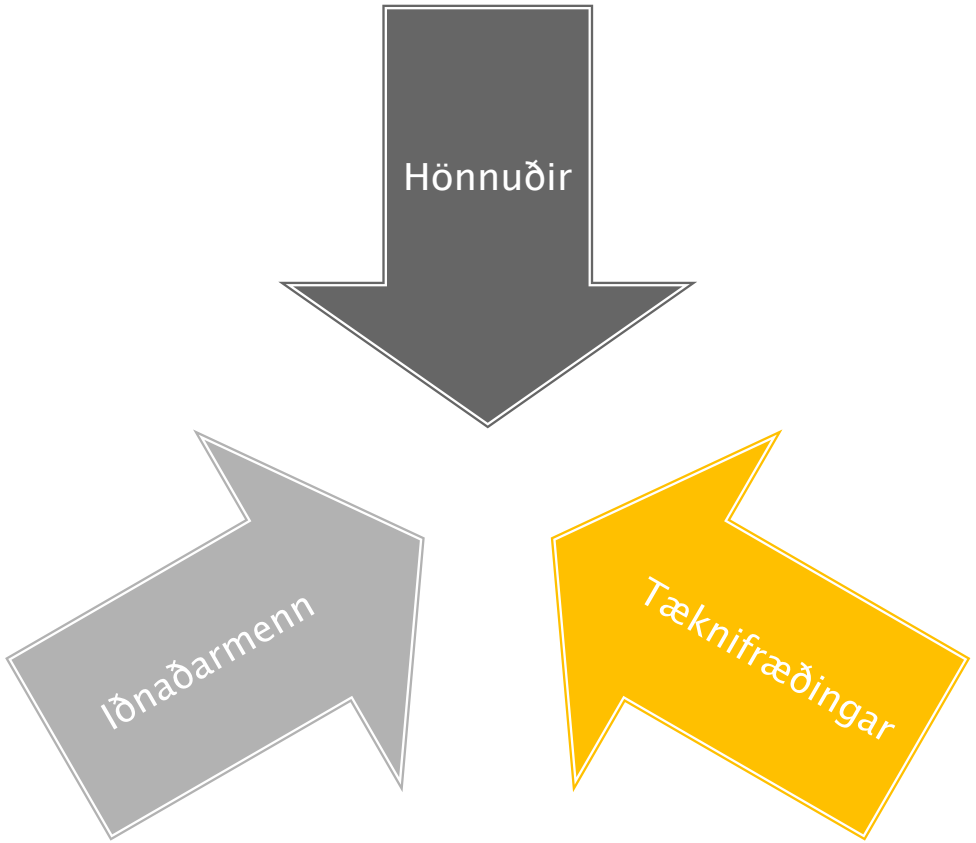


Heilnæm hús ?

- Þurr
- Hrein
- Loftskipti
- Án eiturefna
- Örugg
- Án spilliefna
- Vel viðhaldið
- Íbúar meðvitaðir um loftskipti, byggingarefni og rakabúskap
  - Opna glugga, þurrka þvott og svo framvegis
    - Hvaða efni á að velja – vitund neytenda lítil


Heilbrigðisstéttir
• Læknar
• Lýðheilsufæðingar
Byggingargeirinn
• Reglugerðir
• Hönnuðir
• Eftirlitsaðilar
• Framkvæmd
Skoðunaraðilar
• Opinberir
• Einkaaðilar
Rannsóknaraðilar
• Líffræðingar
• Eðlisfræðingar
• Efnafræðingar
• og fleiri
Íbúar
• Húseigendur
• Leigutakar
• Starfsfólk
• Nemar
Heilnæm hús

Fagstéttir – byggingar



Upplýsingaflæði

- Húseigandi þarf aðgengi að upplýsingum og fagaðilum
- Byggingaraðilar þurfa upplýsingar um hvort og hvenær ástand er talið varasamt, forvarnir, ,,rétt“ efni, endurbætur
- Heilbrigðisstéttir – upplýsingaflæði um rannsóknir og niðurstöður
  - Þurfa einnig upplýsingar um að þessi vandamál eru oftast falin og því sjaldan hægt að meta af íbúum.
  - Skoðunaraðilar og heilbrigðisstéttir – þurfa að skilja niðurstöður skoðunar
  - Engin klínísk próf eru til vegna ,,húsasóttar“
- Eftirlitsaðilar þurfa að hafa kunnáttu, tækni og búnað til þess að sinna sínum skyldum.
  - Sýnataka vandasöm, erfitt að túlka, þarf sjaldan en er stundum nauðsynleg.

  - Mikilvægt að kortleggja vandamálið

Dæmi um upplýsingar sem þurfa að berast á milli stétta:

- Rannsóknir um áhrif efna og aðferða til hreinsunar
- Efnisval í byggingar, hvaða byggingarefni henta
- Niðurstöður um stærðargráðu vandamálsins hérlendis
- Hvernig er mælt með að skoða húsnæði
- Hvernig þarf að laga til þess að auka líkur á að íbúar eða starfsfólk geti snúið aftur án einkenna.

Skoðun á Íslandi

- Mygla falin/hulin í flestum tilfellum
  - Um 20% tilfella er hún sýnileg
  - Toppurinn á ísjakanum ?
  - Þurfum að nota rakamæla til að gefa okkur vísbendingar (steypt hús)
  - **Fólk þarf að njóta vafans umfram byggingar**
    - Ef einkenni eru tengd viðveru í ákveðnu húsnæði þarf að skoða það sérstaklega þar sem ekkert er sýnilegt.

Iðnaðarmenn

- MIKILVÆGUR HLEKKUR
- Þekkja og viðurkenna vandamálið
  - viðbrögð og hreinsun á rakasvæðum þar sem er grunur um myglu.
- Loftgæði geta versnað með röngum viðbrögðum
  - Þessar upplýsingar þurfa að berast til þeirra:
    - Stress ástand myglunnar
    - Gró og afleiðuefni margfaldast við rask og þurrkun
    - Þurr mygla heilsupillandi
    - Efni og þurrkun dugar ekki til árangurs
- **Þurfa að verja sjálfan sig – og aðra**
- **Forvarnir og forðast slæm vinnubrögð**
  - **Mikilvægt að reyna að fyrirbyggja rakavandamál**

Bloom, 2007, skólarannsókn í Finnlandi

Mygluhemjandi málning og þéttiefni

- Mygluhemjandi málning og þéttiefni- stöðvar ekki vöxt en hefur aðeins lítillega hemjandi áhrif (Kórea)
- Mould Germination and Growth on Single and Multi-layered Building Materials at Different Environmental Conditions
- (Hyeun Jun Moon1 ofl , 2009)

Remediation of mould damaged building materials—efficiency of a broad spectrum of treatments

Mirko Peitzsch,[ac] Erica Bloom,*[b] Rocco Haase,[d] Aime Must[b] and Lennart Larsson[a]

Received 5th October 2011, Accepted 14th December 2011

- Tilgangur:
  - Kanna hvort að efni sem eru til í lausasölu geti stöðvað vöxt myglu og/eða stöðvað framleiðslu myglusveppaeiturs.

- Niðurstaða:
  - Ekkert efna / aðferðir náðu að stöðva algjörlega vöxt myglunnar né framleiðslu allra eiturefna
    - sumum tilfellum jókst framleiðsla eiturefna umfram viðmið eftir hreinsun og þurrkun.

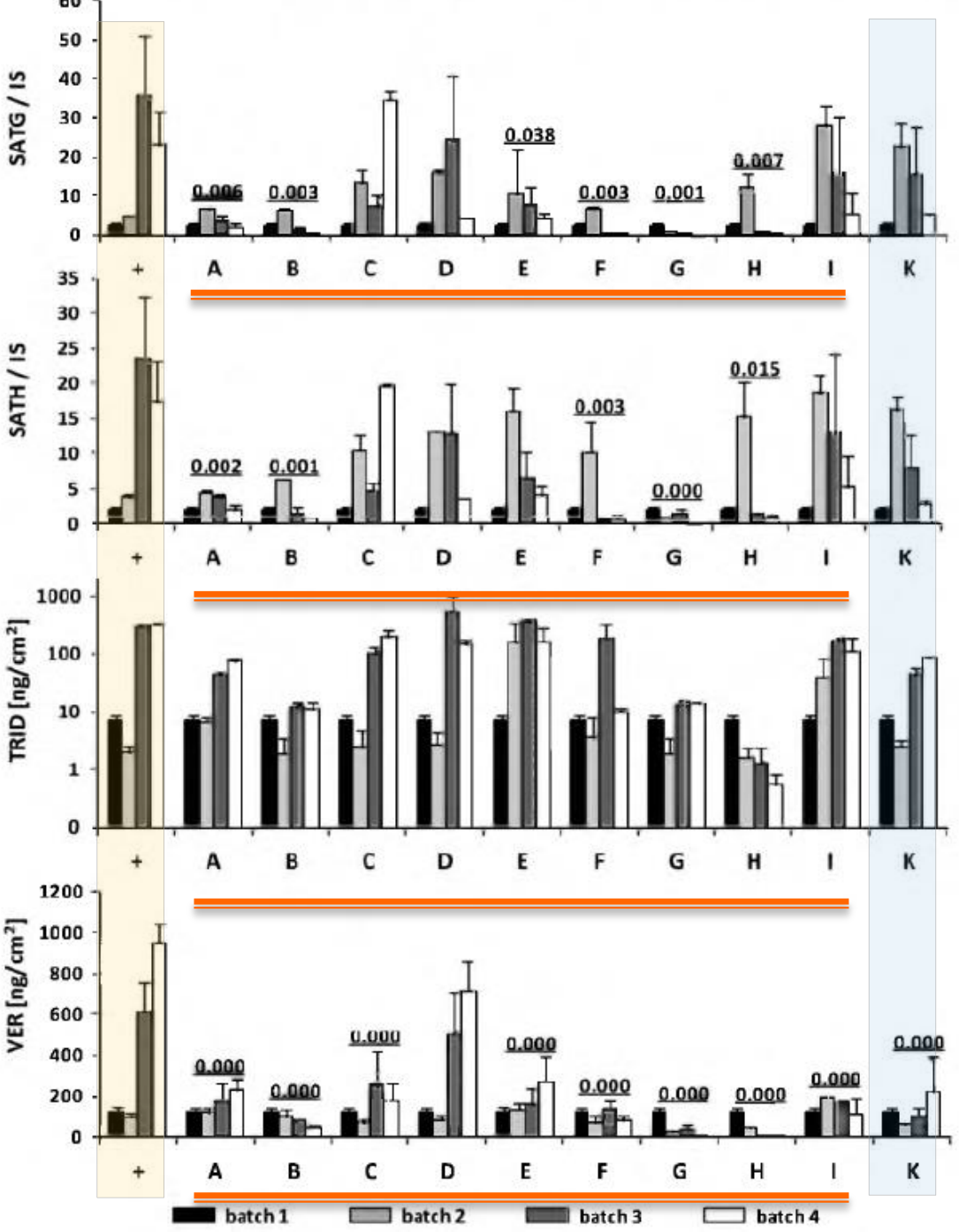


Fig. 3 Amounts of mycotoxins in the building material samples before (batch 1) and 24 h after (batch 2) treatment, and after drying (batch 3) and re-

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE 54:269–277 (2011)

Lack of Respiratory Improvement Following Remediation of a Water-Damaged Office Building

Yulia Y. Iossifova, MD, PhD,[1,2] Jean M. Cox-Ganser, PhD,[2] Ju-Hyeong Park, ScD,[2] Sandra K. White, MS,[2*] and Kathleen Kreiss, MD[2]

- Conclusions During dampness remediation, relocation may be health protective and prevent incident building-related respiratory cases. Without relocation of entire workforces, medical surveillance is advisable for secondary prevention of existing building-related disease.

Rannsókn: 20 hæða skrifstofubygging 1994

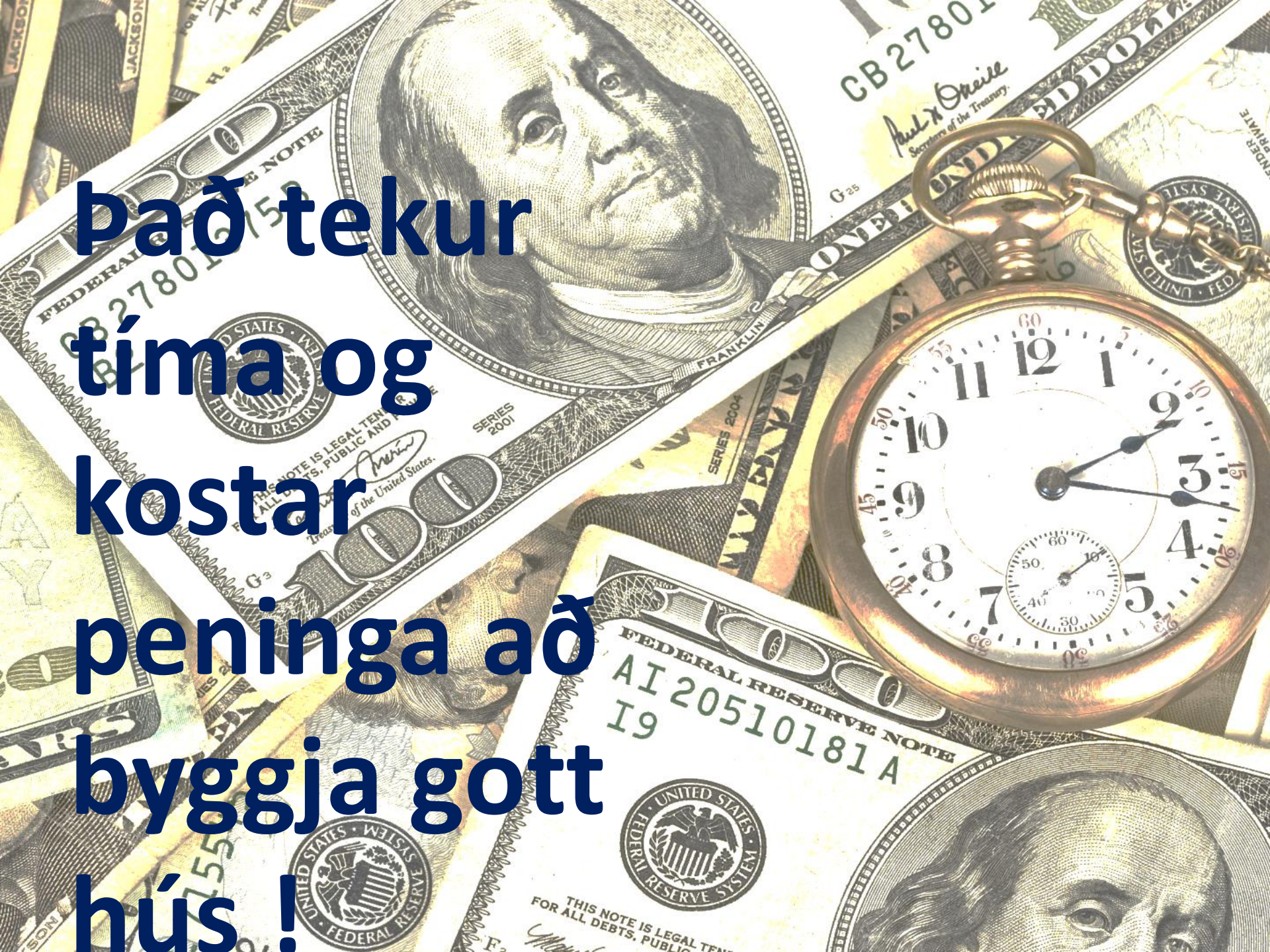
- 1995-2001 – 60 kvartanir skráðar vegna ,,húsasóttar“.
- Leki frá þaki, leki í kringum glugga, lagnir láku á stöku stað.
- Spurningalistar: Eftir að nýja húsnæðið var tekið í notkun 7,5 (OR) sinnum meiri líkur á að fá astma/tilfelli 3,3 (OR) önnur öndunarfæraeinkenni og fleira.
- 2001-2004 viðgerðir fyrir 7,5 milljónir USD
- Skipt um þak, teppi hreinsuð, teppi fjarlægð og innveggir, baðherbergi tekin í gegn, skipt um loftræstikerfi og fleira
- **Fór framhjá verktökum að rakavörn vantaði og var ábótavant.**
- Rakavandamál voru enn til staðar 2005, mælingar sýndu einhverja en litla lækkun með sýnatökum

Niðurstöður:

- Þeir sem voru fluttir annað
  - Einkenni minnkuðu, ekki hjá hinum
  - Engin breyting í einkennum hjá þeim sem voru á vinnustaðnum 2001-2005 á meðan breytingar áttu sér stað
  - Aðrar rannsóknir hafa sýnt svipaða niðurstöðu.
  - Enginn náði sér alveg
  - **Staðfestir mikilvægi forvarna og að grípa inn í strax á byggingarstigi**
  - **Ekki æða í kostnaðarsamar framkvæmdir án þess að kortleggja vandamálið vel**

Forvarnir mikilvægar

- Í **75-80% tilvika** skemmast byggingar vegna raka (Bomberg, Brown, 1993; Ronald, 1994).
- Kostnaður viðgerða eykst þar sem eru rakasæknar lífverur.
  - Niðurrif og hreinsun
- 40% dýrara að lagfæra eftir að fólk er flutt inn (Atila Novoselac, Indoor Air 2011).
- 10-15% einkenna ganga ekki til baka (Wolfgang Lorenz, Bioaerosol 2011)


Það tekur
tíma og
kostar
peninga að
byggja gott
hús !

Ástæður rakavandamála

- Rakaþétting, kuldabrú, loftskipti, þétt hús

SP Technical Research Institute of Sweden

Critical Moisture Conditions for Mould Growth on Building Materials

P44

Pernilla Johansson, Annika Ekstrand-Tobin, Gunilla Bok
SP Technical Research Institute of Sweden

Introduction

Building materials vary in their susceptibility to mould growth. In terms of relative humidity and temperature, some materials can withstand favourable conditions longer than others before mould growth occurs. It is crucial to know how the materials will resist the expected moisture loads in the construction in order to design healthy buildings with low risk of microbiological growth. This poster presents partial results from a study where one of the objectives is to develop a relevant test method to find the critical moisture level for a specific building material. Critical moisture level here is defined as the lowest moisture level above which mould may develop.

Materials and methods

Mould growth has been studied in different climates on ten building materials. For each material there were six replicates and the test pieces were inoculated with a suspension of mould spores from *A. versicolor, A. pullulans, C. sphaerospermum, E. herbariorum, P. chrysogenum* and *S. chartarum*. The material samples were then incubated in climate chambers for at least twelve weeks. The temperature and relative humidity was logged every fifth minute.

Once a week, the test pieces were analysed and the extent of growth was assessed according to a five-grade scale:
0=no growth, 1=trace

Results

Material	Within 12 weeks		Within the entire test period	
Pine sapwood				
Plywood				
Chipboard				
Thin hardboard				
Wall-board gypsum plaster board				
Exterior gypsum plaster board				
Asphalt paper				
Cement-bound board				
Glass fibre board				
Extruded polystyrene board				

*This maximum moisture level and incubation time in the study

Critical moisture levels for the tested materials at 22°C within 12 weeks and within the entire test period. The measurement uncertainty (k=2) is estimated to be ± 1.2% RH and ± 0.15°C.

Samples with visible discoloured growth and non-visible growth, all assessed as rating 4

Conclusions

When testing materials for the critical moisture level for mould growth it is important to consider not only the critical moisture humidity but also:

- The assessment criteria for acceptable growth
- The temperature
- The duration of climate exposure in test setup

It is not possible to predict the critical moisture level of a specific brand of material by using results for a similar material or group of materials produced by a different brand. Therefore we suggest that each brand's material must be tested individually with the same test method.

Samples with visible discoloured growth and non-visible growth, all assessed as rating 4


2011.09.22


2011.09.22


2011.09.22


2012.06.05


2012.06.05


Ziploc
2012.06.05


2012.06.05


S26
Pullman Ermator

Linoleum dúkar eða límið undir þeim virðist vera í uppáhaldi!


2011.04.05


Linoleum dúkur undir parketi, ekkert sjáanlegt á parketinu