HEALTH ISSUES IN RELATION TO BUILDING DAMPNESS IN EUROPEAN SOCIAL HOUSING

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ABSTRACT

Scientific evidence exists of an association between dampness and mould in buildings and of an increased risk of health effects for occupants, usually associated with the respiratory system. It is difficult to establish the exact prevalence of residential dampness, but according to WHO, it is likely to be in the order of 10-50%.
The aim of this study is to examine the frequency of indoor dampness in social housing in different European countries, and whether dampness in these residential buildings is related to health issues such as asthma or allergies. Both, dampness (condensation on windows and /or walls and mould growth) and symptoms were surveyed by standardized questionnaires filled-out by the household occupants. In total, 215 residences are included in the study. Results indicate that dampness is around 16% and that mould is significantly related to asthma or other respiratory symptoms and allergies (odds ratio (OR) around 2.6)).

KEYWORDS

Dampness, mould growth, asthma, odds ratio

1 INTRODUCTION

Respiratory symptoms and asthma are among common diseases in Europe and worldwide. The prevalence of asthma has increased during last decades, and there are indications that this may be partially due to allergic and non-allergic reaction to indoor environment.
Several cross-sectional studies during the last years have observed an increased risk of respiratory symptoms and other diseases which are related to exposure to mould in damp or mouldy buildings: condensation on cold surfaces, permanent dampness in the building construction or episodes of water leakage and high indoor air humidity facilitate microbial growth (Peat et al. 2008; Norback et al. 1999).
Scientific evidence exists of relation between these symptoms and to exposure to mould in damp or mouldy buildings (Bornehag 2001; Bornehag 2004; WHO 2009; IOM 2004; Muddari 2007). Bornehag (2001) lists 51 studies, in most of which a relationship exists between self-reported dampness and asthma, coughing and wheezing, with odds ratios (OR) ranging from 1.4 to 2.2.
According to the review of the Institute of Medicine (IOM) of the National Academy of Sciences (IOM, 2004), dampness problems are common and excessive indoor dampness consists a public health problem: building dampness may cause the building to become contaminated with microorganisms such as mould or bacteria, which might in-turn cause adverse health effects. Building dampness could also cause increased emissions of some chemical pollutants from materials and surfaces (IOM, 2004). Research has not yet

determined the exact causal agent(s) (IOM, 2004). The increased risk associated with building dampness suggests a potentially large public health problem. Most available data indicate that at least 20% of homes have dampness problems or visible mould.
In their analysis, Muradi and Fisk (2004) found sufficient evidence of a relationship between dampness or mould exposure and upper respiratory symptoms, as well as significant health and economic risks in the USA.
The present study is a part of the EC funded ICE-WISH project which commenced in 2011 with the primary objective of improving energy efficiency in social housing using ICTs, while ensuring that the conservation measures will have no adverse influence on Indoor Environmental Quality (IEQ). Of equal importance to the project, is the quantification of the improvements in IEQ, as well as the identification of possible non-energy benefits for the participants, such as the prevention of adverse health effects that can result from dampness and mould.
The study consists of quantitative surveys matched with a set of measured parameters (indoor air temperature, indoor air humidity and indoor CO_2 concentrations), and is designed to follow a longitudinal design approach, i.e. occupant surveys and relevant data collection will be performed before, a few months after, and at least one year after the ICE-WISH service implementation.
This paper presents results from the baseline survey, conducted in late 2011 to 2012 within seven European countries: Belgium, Denmark, France, Germany, Italy, Poland, and Spain.
The aim of the work presented in this paper is to examine the frequency of indoor dampness in social housing in different European countries, and whether dampness in these residential buildings is related to health issues such as asthma, stroke or other circulatory problems, rheumatisms, skin symptoms or allergies.

2 DATA AND METHOD

To ensure European replication, the sampling frame consists of a population of low income occupants living in social housing across 7 different European countries. A total of 215 households have completed the tenant questionnaire.
This questionnaire covered a broad range of topics, including demographics and socioeconomics, smoking habits and time spent in the home. The analysis presented here focuses on the health issues and dampness and mould conditions present in individual dwellings which were also specifically addressed in the questionnaire. The analysis is based on participants' responses.
Symptoms related questions:
The participants were asked whether they or anyone in the household suffer from any of the following symptoms: (a) 'asthma or other respiratory problems', (b) 'stroke or other circulatory problem', (c) 'rheumatism or other joint problem', (d) 'Eczema or other skin condition', (e) 'allergies', (f) 'colour blindness' and (g) 'requires use of a wheel chair'.
Symptoms included in the following analysis are: Asthma (asthma or other respiratory problems); Stroke (stroke or other circulatory problems); Skin (Eczema or other skin condition), and; Allergies. Participants were asked if they suffer from any of the above health issues. For each symptom, there were only two answers: "yes" or "no".
Building's dampness condition related questions:
The questionnaire included also queries about the dampness conditions in dwellings. In particular, participants were asked if they have noticed: condensation on the windows/walls/ceilings; damp patches on the walls/ceiling; mould on the walls/ceiling, and mould on the furniture, carpets or clothes.
The question on dampness conditions was repeated for the following room types: kitchen, bathroom, bedroom, living-room and any other space. Thus, in total, respondents had to

answer 20 items concerning dampness conditions in their household (4 dampness conditions for 5 different space types). For each question, there were again only two answers: "yes" or "no".
For the 215 tenant questionnaires, binary logistic regression analysis was applied and odds ratio with 95% confidence intervals (OR: 95% CI) were calculated.

3 RESULTS

Table 1 shows symptoms and dampness conditions observed from the results of the survey. Namely, asthma or other respiratory symptoms were found for 15.9% of the studied households, stroke or other circulatory symptoms were found in 7.7% of the households while, rheumatism symptoms, skin symptoms and allergies were found in 13.3%, 7.2% and 30.3%, of those studied, respectively. The most prevalent symptoms are allergies and asthma. There are no statistically significant differences in any of the symptoms between different countries, except for rheumatism (Fisher's exact test =28.464; $p<0.001$). Nonetheless, variations are observed among the studied countries in asthma symptoms with distribution ranging from 0% in Italy to 41.7% in France.
Of the total of 215 households that participated in the study, 22.3% reported condensation on windows, walls and/or ceilings, and 16.7% reported mould growth (9.8% had damp patches, 7.9% had mould on walls/ceilings and 1.4% had mould on furniture (Table 1)). There are no statistically significant differences in any of the symptoms between different countries.

Table 1: Descriptive overview of the European Countries included in the study

	Belgium	**Denmark**	**France**	**Germany**	**Italy**	**Poland (EG)**	**Spain**	**Poland (CG)**	**Total estimate**
Symptoms									
Asthma	20.0%	12.0%	41.7%	8.3%	.0%	6.7%	22.2%	26.7%	15.9%
Stroke	4.0%	24.0%	25.0%	8.3%	.0%	3.3%	3.7%	3.3%	7.7%
Rheumatism	16.0%	20.0%	58.3%	16.7%	.0%	3.3%	18.5%	.0%	13.3%
Skin	4.0%	24.0%	8.3%	12.5%	.0%	3.3%	7.4%	.0%	7.2%
Allergies	28.0%	20.0%	41.7%	41.7%	31.8%	30.0%	25.9%	30.0%	30.3%
Dampness Conditions									
Condensation	27.6%	33.3%	19.0%	48.3%	18.2%	.0%	29.6%	3.3%	22.3%
Damp patches	17.2%	17.9%	19.0%	16.7%	29.2%	13.3%	20.7%	3.3%	9.8%
Mould structure	6.9%	7.4%	.0%	13.8%	18.2%	.0%	14.8%	3.3%	7.9%
Mould Furniture	.0%	.0%	.0%	3.4%	.0%	.0%	7.4%	.0%	1.4%

Dampness conditions are more prevalent in bedrooms and bathrooms (Table 2), and they involve mainly condensation problems in walls, windows and/or ceilings. Mould growth in structure components is more prevalent in bathrooms, while mould growth on furniture and carpets is more prevalent in bedrooms (Table 3).

Table 2: Dampness frequency per room type

Room Type	**Dampness per room type (n=215) (%)**
Kitchen	15.8
Bathroom	**18.2**
Living Room	13.9
Bedroom	**19.4**

Other Place	8.5

Table 3: Dampness conditions per room type

	Condensation	Damp patches	Mould /Structure	Mould/Furniture
Kitchen	14.0	3.7	3.0	0.6
Bathroom	15.2	**5.5**	**4.9**	0.6
Living Room	12.2	4.9	3.0	0.6
Bedroom	**15.9**	5.5	3.0	**1.8**
Other space	7.3	3.0	2.4	**1.8**

In a further analysis, mould in structures and mould in furniture were grouped together to form the constructed variable "mould growth". The values for "mould growth" were defined as 1, if the answer was positive to the existence of mould on structure or mould on furniture, and 0, if the answer was negative.

Results of the binary logistic regression are presented in Table 4. As observed from Table 4, there is a statistically significant association between damp patches and asthma (OR, 3.437 (95% CI, 1.072-11.022)) and between damp patches and skin symptoms (OR, 4.752 (95% CI, 1.285-7.573)). None of rheumatism, stroke or other circulatory symptoms are associated with any of the dampness conditions. Allergies on the other hand, are significantly related to condensation.

Table 4 Each symptom related to the building dampness conditions (OR (95% CI))

	OR (95% CI)		
Symptom	**Condensation**	**Damp patches**	**Mould growth**
Asthma	1.657 (.638-4.303)	**3.437 (1.072-11.022)****	2.588 (.750-8.937)
Stroke	0.736 (.193-2.804)	1.661(.336-8.210)	.761(.092-6.268)
Rheumatisms	1.723 (.718-4.133)	.689 (.148-3.209)	.744 (.159-3.487)
Skin	3.036 (.999 9.221)	**4.752 (1.285-7.573)***	1.792 (.360-8.911)
Allergies	**2.108 (1.005-4.422)***	1.250 (.413-3.784)	1.376 (.449-4.219)

Next, to address dose response relationships between symptoms and exposure to dampness, the OR for category I and category II were calculated. Categories are defined as follows: Category 1, if the answer included any one of the four dampness conditions; Category 2, if the answer included all dampness conditions. The results of the calculations are summarized in Table 5. It can be observed that, as the level of dampness increases, the OR for asthma and allergies symptoms increases also.

Table 5 Each Symptom related to the building dampness conditions. Category I any of the dampness conditions, Category II both dampness conditions (OR (95% CI))

Symptom	**OR (95% CI)**	
	Category I	**Category II**
Asthma	**2.671 (1.055-6.762)***	1.330 (0.339-5.221)
Skin	2.688 (0.856-8.440)	1.472(0.28-7.747)

Allergies	1.886 (0.913-3.897)	**2.689 (1.094-6.610)****

4 CONCLUSIONS

In total 215 households were examined in the present study, within seven different European countries.

Building dampness was reported by 16% of the population in this study, while condensation in structural parts of dwellings was reported by 22% of the same population. These percentages are based on self-reported questionnaires with no objective measurement of conditions or symptoms.

The most prevalent symptoms among participants are allergies and asthma.

Main results of this study indicate an increased risk of asthma and allergies (ORs of around 2.7). The increased prevalence of asthma and other respiratory symptoms is predominately present for participants reporting damp patches, while allergies are more prevalent for participants reporting all conditions of dampness.

No association was found between dampness conditions and stroke or other circulatory symptoms and rheumatism. This could indicate that building dampness does not cause these symptoms.

We conclude that building dampness is not a common problem in the countries participating in this study, but in cases where dampness is present there is also an increased prevalence of asthma and allergies. With regards to the considerable scientific evidence that dampness and mould do affect peoples' health, it is clear that the consideration of corrective, preventive and/or remedial actions is necessary for the reduction of this health risk.

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6 REFERENCES

Bornehag, C.G., Sundell, J., Bonini, S.,Custovic, A., Malmberg, P., Skerfving, S.,Sigsgaard, T. and Verhoef, J. (2001). Dampness in buildings and health. Nordicinterdisciplinary review of the scientificevidence on associations between exposure to dampness and health effects.NORDDAMP. *Indoor Air*, 11, 72–86.

Bornehag, C.G., Blomquist, G., Gyntelberg,F., Jarvholm, B., Malmberg, P., Nordvall,L., Nielsen, A., Pershagen, G. And Sundell, J. (2004) Dampness in buildings as a risk factor for health effects, EUROPO.A multidisciplinary review of the literature (1998–2000) on dampness and mite exposure in buildings and health effects, *Indoor Air*, 14, 243–257.

Institute of Medicine (IOM), (2004). Board on Health Promotion and Disease Prevention, Committee on Damp Indoor Spaces and Health. Damp indoor spaces and health, Washington, DC: The National Academies Press, available at: http://www.nap.edu.

Mudarri, D., Fisk, W.J. (2007). Public health and economic impact of dampness and mold. Indoor Air, 17, 226–235.

Norback, D., Bjornsson E., Janson C., Palmgren U., Boman G. (1999). Current asthma and biochemical signs of inflammation in relation to building dampness in dwellings. *Int J Tuberc Lung Dis*, 3, 368–376.

Peat, J.K, Dickerson J., Li J. (1998). Effects of damp and mould in the home on respiratory health: a review of the literature. *Allergy*, 53, 120–128.

WHO 2009 WHO. WHO guidelines for indoor air quality: dampness and mould. World Health Organization.