Impact of mould and dampness on the prevalence of having asthma in European homes

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SUMMARY
The occurrence of dampness is one of the major defects in dwellings across Europe, which is typically a result of defective building structures and adverse occupant behaviour. Consequently, dampness is likely to lead to mould growth and other associated structural damages. This paper aims at showing the impact of mould and dampness on the prevalence of having asthma in European homes. To evaluate the magnitude of the effect of mould in homes, a meta-analytic synthesis has been performed. In the case of asthma, the meta-study yielded that the odds ratio of having asthma in a damp and mouldy dwelling is significant with a value of 1.4. The analysis of the prevalence of people having asthma shows, that there is a higher share of people having asthma, if they live in damp or mouldy dwellings.

KEYWORDS
Indoor Environment, Mould and Dampness, Asthma, Impact on Human Health

1 INTRODUCTION
This paper aims at showing the impact of mould and dampness on the health of inhabitants. To achieve a magnitude about the effect of mould in homes on respiratory diseases, a meta-analytic synthesis has been performed. In a further step, a projection about the potential of modernizing the building stock and reducing mould sources on lowering the impact on the inhabitant’s health has been made.

The occurrence of dampness is one of the major defects in dwellings across Europe, which is typically a result of defective building structures and adverse occupant behaviour, e.g. by insufficient ventilation. As a consequence dampness is likely to lead to mould growth and other
associated structural damages. Moulds are species of fungi and require mainly four prerequisites to grow: a substrate containing sufficient nutrient matter, a suitable surface temperature, sufficient moisture and of course enough time to grow under these circumstances. Amongst the parameters for mould growth the relative humidity indoors is the critical one which can be controlled for effective prevention. However, if the occupant misses to sufficiently remove the moisture produced indoors (e.g. by ventilation) or the building has a defective envelope causing wet walls or insufficient insulation (incl. thermal bridges), conditions supporting mould growth are likely to occur and mould will become visible sooner or later.

There is evidence that the occurrence of mould and dampness is associated with respiratory or allergic health effects. Amongst others it promotes the development of asthma and upper respiratory tract symptoms. For example the overall risk for developing asthma is reported as being approximately 50% higher as if no mould or dampness is detectable in a home (Mendell et.al., 2011). Respiratory tract illnesses are forming one of the major shares of direct health service costs: e.g. in Germany these are around 5 %, which amounts to ca. 13.2 billion Euros per annum (data of 2008) (Statistisches Bundesamt, 2010); and asthma costs for the European economy have been estimated at 19.5 billion Euros each year (data of 2011) (European Respiratory Society, 2016).

This study concentrates on the link between moulds indoors and associated health effects in order to identify the risk of suffering from respiratory illnesses because of living in damp or wet dwellings.

2 MATERIALS/METHODS

Within this study a huge amount of scientific peer-reviewed literature was re-viewed, using over 200 publications dated from 1986 to 2015 (Urlaub and Grün, 2016). Again it can be confirmed that there is a relation between respiratory tract infections and damp and mouldy indoor environments. However, regarding this association there is still uncertainty, how many people are suffering respiratory tract infections because they live in damp or wet dwellings. With the chosen approach of a meta-study this investigation used the odds ratios calculated from the literature in order to derive an indication of a magnitude for this number. A meta-study uses statistical methods to combine results from different studies in order to identify patterns among those study results. For small odds ratios (smaller than 0.1) they are approximately equal to the so called risk ratios, which quantify how strongly the presence or absence of one property (e.g. mould) is associated with the presence or absence of another property (e.g. asthma) in a given population. Given the number of people suffering from respiratory infections (like asthma), which are not living in a damp or wet dwelling from the literature review, the number of people that are impaired in this respect because they live in wet or damp dwellings can be estimated.

The studies which were used to evaluate the influence of mould and dampness on health are observational in their character; experimental studies like clinical trials were not used in this context. In total, the literature search identified 172 scientific studies, of these 99 were conducted as a cross-sectional design, 31 were case control studies and 40 were cohort studies (Urlaub and Grün, 2016). Not all of them were eligible for meta-analysis for different reasons. To evaluate mould or dampness in buildings by questionnaires, different indicators have been identified: visible mould spots, dampness, mould or dampness, mouldy odour, water leakage/damage, condensation, moisture. For the health outcomes asthma, wheeze, cough,
rhinitis, bronchitis, allergic rhinitis, nasal symptoms, eye symptoms, throat symptoms, skin symptoms and common cold, enough studies were available. This study focused on the influence of mould and dampness and their different indicators; additional phenomena that may be caused by or aggravate the influence of mould and dampness (e.g. house dust mites) have been excluded.

3 RESULTS

The share of population living in wet or damp dwellings ranges from 5% to over 30% in the different European countries (see Figure 1), on average around 16% of the population was affected in recent years (Eurostat, 2013). Projected onto the total population statistics (January 1st, 2013) of the European Union plus Iceland, Norway and Switzerland this affects an overall number of about 84 million people.

![Figure 1: Share of total population in European countries living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor – data of 2013, 2012 for Ireland (Eurostat, 2013).](image)

Respiratory diseases are of huge concern worldwide, as to a substantial portion they cause disability and premature deaths. Given this fact there are huge efforts to gain knowledge on the prevalence of such diseases. For the case of clinical asthma the most extensive investigation has been performed with the WHO world health survey (WHO, 2016), which has been analysed also in (To et al., 2012). In order to pool the available prevalence rates onto the region considered in this study the following method has been applied in order to adjust for the different sampling in the countries i:

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P R = \frac{\sum p r_i \cdot s_i}{\sum s_i \cdot w_i} \quad [-] \quad (1)
\]

With \( p r_i \) the prevalence rate in each country \( i \), \( s_i \) the sample size and \( w_i \) is the sampling weight. The sampling weight has been selected as post stratification weight if indicated, else the probability weights have been used or, if not available, the sampling fraction has been computed.
as population size by sample size (data taken from (WHO, 2016)). Using this method the prevalence rate of having asthma in the considered European countries can be estimated at being 7% (approx. 36.3 million people). This proportion has been taken as total prevalence rate for dwellings, regardless of whether they are damp and wet or not.

In summary we know, that mould growth is very dependent on the indoor climate available in dwellings (Sedlbauer, 2001). Basically with ca. 16% a large quantity of Europe’s population lives in wet or damp dwellings (Eurostat, 2013). At the same time there is evidence, that mould is associated with respiratory tract symptoms (Mendell et al., 2011) and a large quantity of the population is affected by respiratory tract illnesses (European Respiratory Society, 2016).

The trends identified by the analysis with respect to mould and health indicators all point in the same direction: all of the odds ratios of different respiratory tract illnesses are above 1, mostly around 1.5 (see Figure 2).

![Figure 2: Relationship between the prevalence of the different health outcomes in cross-sectional studies when the indicator “mould or dampness” is present.](image)

In the case of asthma the odds ratio of having asthma in a damp and mouldy dwelling is significant. In total, 40 cross-sectional studies had been included in the analysis. Figure 3 shows the results for the prevalence of asthma compared to the presence of one mould indicator. For further interpretation the average value of the indicators mould or dampness and dampness has been considered. With this value it can be concluded that the chance of having asthma vs. not having asthma is 40 % higher in damp or mouldy dwellings compared to non-damp or mouldy homes.
Figure 3:
Relationship between the prevalence of asthma and the presence of one of seven mould indicators. The number following each indicator is the amount of underlying studies. Error bars are 95%-confidence limits. Statistically not significant values (p > 0.05) are displayed in grey.

4 DISCUSSION

Together with the figures outlined above, that 16.1 % of the European population live in wet or damp dwellings (approx. 83.5 million people), 7% is the prevalence rate of having asthma in Europe and the risk ratio of having asthma in a damp or mouldy dwelling is 1.4 (cross sectional data) the fraction of the population, who lives in damp or mouldy dwellings and has asthma can be solved. This yields approximately 7.7 Million people who do live in a damp or mouldy dwelling and have asthma, which is a prevalence rate of 9.2% of the population living in damp or mouldy dwellings. As the fraction of the population not living in damp or mouldy dwellings is 6.6%, there are 2.6 % more people having asthma in damp or mouldy dwellings than if they would not live in such dwellings. Thus it can be concluded, that this share of a higher prevalence of having asthma is due to the circumstance of living in damp or mouldy dwellings. Related to the absolute number of people, there are thus approximately 2.2 million people across Europe having asthma because of living in damp or mouldy dwellings.

5 CONCLUSIONS

The investigation finally yields a number of 2.2 million Europeans that have asthma because they live in damp and mouldy dwellings. As a consequence much more attention should be drawn to a high quality of the indoor environment and building fabric. The careful installation of building structures, especially while performing energetic modernisations, becomes more and more important, as buildings become more air tight with the constant efforts to improve energy efficiency. This finally also leads to higher importance of the occupant behaviour with respect to the removal of internal moisture production through ventilation and emphasizes the necessity to develop sufficient demand related ventilation concepts (natural, automated and/or mechanical) for dwellings.
6 ACKNOWLEDGEMENT

The authors express their gratitude to the graduate program “People Inside” at the Chair of Building Physics, University Stuttgart, Germany and Velux A/S, Denmark for a fruitful cooperation and support of this study. This work is benefitting from the research project Building I conducted at the Energy Campus Nuremberg, funded by the Bavarian State Government. The authors are responsible for the content of this publication.

7 REFERENCES