

EDITORIAL

Moulds, mites and childhood asthma

Introduction

Parents often ask 'could my child's chest trouble be due to dampness or mould growth in our home?'. Although there are many mechanisms whereby the indoor environment may affect respiratory health, allergy, particularly allergy to indoor moulds, is the one most commonly underlying this concern [1]. A broader scientific issue thus arises: 'how important are indoor allergens as determinants of the incidence, severity or prognosis of childhood asthma?'. Clinicians and public health policy makers would like to know the answer to both these questions.

Housing conditions and respiratory health in children

Most studies addressing the relationship between housing and chest disease have been cross-sectional in design and have concentrated on children, in order to discount the confounding effects of active smoking, occupation and selection into different types of housing, which pose problems in adults.

The strongest association reported is from a random sample of 1000 7-year-old children in Edinburgh, where current wheeze was three to four times more common among children living in homes reported to be mouldy (odds ratio 3.7). This was statistically highly significant, unaltered by adjustment for multiple confounding variables and relatively specific, in that there was no excess of ear disease, sore throat or hay fever in the homes where mould occurred [2]. Among 1169 children of unspecified ages living on council estates in London, Edinburgh and Glasgow, the association of visible mould with wheeze was somewhat weaker (odds ratio 1.9) and less specific, in that many other symptoms, not all respiratory, were also more common amongst children living in homes with mould problems [3].

Studies from other countries confirm this association between reported dampness or mould growth and respiratory morbidity in children. Among 5301 children in southern Sweden, dampness in the home was associated with prolonged cough after infection (odds ratio 2.3), exercise-induced cough (1.7) and allergic asthma (1.8) [4]. Among 4600 children aged 8–12 in the eastern U.S.A., reported mould growth was significantly associated with wheeze on most days or nights (odds ratio 1.8) and persistent cough (2.1), but not with doctor-diagnosed asthma (1.3) [5]. A study of over 12 000 Canadian children aged 5–8 years, found a modest association between damp or mould-infested housing and both asthma (1.5) and other forms of wheezing (1.6) [6].

Few studies have progressed beyond questionnaire data to attempt objective or independent assessment of housing conditions or allergic symptomatology. Such confirmation is particularly important in the context of assessing the health effects of damp or mouldy housing, because the hypothesized association is widely accepted by the responding public and may already be a focus for local discontent about inadequate or undesirable housing conditions. General practitioner records [7], and measurements of exercise-induced airflow obstruction [2], and of resting lung function [5] indicate relationships with mould which are either equivocal or non-existent, raising the possibility that at least some of the association between respiratory morbidity and housing conditions in questionnaire surveys is a manifestation of differential symptom reporting by parents who are aware of mould in their home [2].

Indoor humidity and mould growth

Two studies have monitored indoor air temperature and relative humidity in the homes of children with and without respiratory symptoms in the U.K. Among 156 children in north-east England higher relative humidity was measured in the bedrooms of children with lower respiratory complaints [8], whereas similar studies in the bedrooms of 330 children in Edinburgh, did not find a strong or significant relationship between any respiratory symptom or lung function index and either temperature or relative humidity [9].

Three studies derived from general population surveys have reported airborne spore counts in relation to lower respiratory symptoms in children. Platt *et al.* [3] found a correlation between total airborne spore count measured on a single occasion and reports of wheezing in children from 485 homes. This was consistent with the association between this symptom and assessment of dampness or mould growth by an independent surveyor in the same study. Van Wageningen *et al.* [10] also reported a significant association between elevated fungal spore levels and chronic non-specific lung disease in a study of 202 children in The Netherlands. In contrast, Strachan *et al.* [11] found no difference in the geometric mean total spore count from the homes of 34 wheezy children and 54 controls visited four times over a winter period. The main types of mould identified were distributed widely, no one species predominating in the air of visibly mouldy homes. Concentrations of airborne spores were low by comparison with summer outdoor concentrations.

House dust mites

House dust mites are known to thrive in humid microclimates and higher mite counts are found in homes with relative high indoor humidity [12]. Mites are especially difficult to eradicate from damp bedrooms [13]. The majority of older children and young adults with asthma experience positive skin-prick reactions to house dust mite allergen. This association appears to be more specific for mite allergen than for other aero-allergens, such as grass pollen [14,15], suggesting that it is mite allergy, rather than allergy in general, which is the important risk factor. This raises the possibility that higher levels of mite allergen exposure account for the apparent excess of respiratory symptoms among children living in damp or mouldy homes.

Studies within populations with varying levels of mite exposure are required to determine thresholds for allergic sensitization and clinical disease. Two early studies of live mite counts in the homes of asthmatic adults and controls gave conflicting results [16,17] but these findings are of limited value as live mite counts are only moderately correlated with mite allergen exposure.

More recently, measurements of mite allergen levels have been related to asthma in children. Sporik *et al.* [18] found a fivefold increase in asthma among children of atopic parents in southern England who were exposed to more than 10 $\mu\text{g/g}$ *Der p* I in the first year of life. The more heavily exposed children also tended to experience onset of symptoms at an earlier age. This influential paper suggested that allergen exposure in infancy was more important than current exposure in determining the occurrence of asthma. However, with only 67 children in the cohort, the study lacked statistical power to distinguish conclusively between the effects of these correlated exposures. Burr *et al.* [19] found no association between *Der p* I exposure and wheeze in the first year of life in a similar study of the offspring of atopic parents in south Wales. A population-based case-control study of childhood asthma in south London [20] found very similar distributions of mite allergen (estimated by guanine content) in dust samples from the homes of 271 wheezy children, 202 formerly wheezy children and 245 controls with no history of wheeze.

Levels of mite allergen in the dust in these surveys from southern Britain are generally above the suggested hygiene standard of 2 $\mu\text{g/g}$ [21], and it is possible that most people in Britain are exposed to enough mite allergen to cause asthma in susceptible subjects. A paper published in this issue of the journal [22] reports remarkably similar prevalences of asthmatic symptoms and mite sensitization in two areas of Australia with very different mite allergen levels. This suggests that the burden of

childhood asthma in a population may be only tenuously related to mite allergen exposure, despite early observations of symptomatic, physiological and immunological improvement in asthmatic children removed from a mite-infested environment by institutionalization at high altitude [23].

Conclusions

There is evidence of clear causal relationships between the indoor environment (particular humidity) and mite infestation, between mite infestation and allergen exposure, and between mite allergy and symptomatic respiratory disease. However, studies relating mite infestation or mite allergen exposure to allergic sensitization and symptomatic disease are inconsistent, and the nature of the dose-response relationship, particularly at low levels of exposure, remains unclear [24]. Further clarification of the dose-response and evidence of the magnitude of differences in allergen exposure between damp and dry homes will be required before we can assess the contribution of mite allergy to the association between damp, mouldy housing and childhood asthma.

The contribution of mould allergy is even less clear. All homes contain airborne mould spores and many of these species are also found outdoors. Although much of the literature relates childhood asthma to indoor mould exposure, predominantly outdoor species such as *Alternaria* may be of equal, or greater, importance [22]. The contribution of domestic exposure to the cumulative inhaled spore burden is unclear, and it is possible that everyone is exposed to enough mould spores to induce or sustain asthma in the susceptible minority. However, this situation, which is typical of pollen allergy, would not result in the differences in symptom prevalence between mouldy and non-mouldy homes which are observed in most epidemiological studies.

Such associations could be explained if domestic mould growth influenced personal mould spore exposure and a sufficient proportion of the population were sensitized to moulds to result in differential rates of disease. Although a large number of potentially allergenic mould species have been isolated from homes [25], skin-prick reactivity to the most common groups of moulds appears to be uncommon, both in absolute terms and by comparison with other domestic allergens such as house dust mites and household pets. This argues against mould allergy as an important mechanism linking damp, mouldy housing and asthma [1]. Nevertheless, the possibility remains that spores or chemical products from some, as yet unidentified, fungus may be responsible for the increased prevalence of asthmatic symptoms among children living in homes with visible mould growth.

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