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Utility of measuring allergen content in house dust samples in a cross-sectional study of respiratory health and atopy in a cohort of immigrant families in poor-quality housing in Malmö, Sweden

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Abstract
Exposure to allergens plays a role in the development of atopic sensitization and influences allergic phenotype. House dust mites (HDM) are a common source of allergens in many parts of the world. The relationship between indoor environment factors such as temperature, moisture/humidity, and ventilation and HDM allergen load is complex.

Methods
Part of a larger study into the health in its social context of an immigrant population living in poor-quality housing in Malmö, Sweden. Families with small children were identified from health care records (child treated in primary care with respiratory illness), and school records (matched for age range). Families were visited in their homes by health care professionals fluent in the language. For 4-6 visits, air samples were taken using standardised and reproducible methods. Parent and individual level health data, including skin-prick-tests for a standard panel of allergens, were analyzed together with environmental exposures (moist, dampness, ETS, crowding and allergen content) in the part of the study presented here. Allergen content was analyzed for house dust mites and cockroach allergens: Der p1, Der f1, and Bla g, from dust samples collected in the affected apartments. Allergen content was measured using sandwich ELISA.

Results
130 families participated, with usable data for 359 children under the age of 12, 61 older children and 230 parents. The overall exposure to potentially harmful factors was relatively high, the burden of atopy and respiratory diseases was significant. Dust samples were collected in all 130 apartments. Correlations between apartment characteristics, allergen content and health outcomes in this vulnerable population are explored and discussed against the framework of a model explicitly accounting for social determinants of health.

Conclusions
The utility of allergen content measurements in the context of this study was rather limited, as it did not add vital information that could further elucidate pathways and connections between environmental exposures and health outcomes.

BACKGROUND
In 2008, the public in Sweden became aware of the extremely poor housing conditions in certain areas of Malmö. A predominantly immigrant neighborhood in Malmö (county of Skåne, southern Sweden) was majorly affected. The neighborhood had been severely neglected by the proprietors for years. Apartments in the affected neighborhood, Herningsö, were overcrowded, damp, affected by mould, and inhabited by cockroaches and other vermin. The main property owner, after massive media attention and subsequent court trial, received an injunction from local authorities to perform extensive renovations within 90 housing units. This provided a unique opportunity to examine whether the health of children living in this neighborhood had been affected by poor indoor environmental factors. Preliminary results from primary care centres had indicated unusually large numbers of children with asthma. The study approach also considered the social determinants of public health.

MATERIALS AND METHODS
Because the main study design was a prospective intervention study looking at the effect of the housing renovation on respiratory health in children, children with respiratory symptoms were included. Allergens were identified from records of the local health centres. These children and their siblings along with the parents were invited to participate in the study. In addition, a second set of children were defined from class lists at the local school, based on the siblings and parents. These families lived in a nearby area, Tımussom, with buildings of similar age and construction, but with appropriate upkeep.

Base-line study
A total of 359 children were recruited, including 181 children from 53 apartments in Herningsö and 198 children from 77 apartments in Tımussom. Initial home visits were carried out between May 7, 2010, and May 29, 2011. A prospective cohort of 150 families was defined from dust samples from the baseline, identified from records at the local health centres. These children and their siblings along with the parents were invited to participate in the study. In addition, a second set of children were defined from class lists at the local school, together with their siblings and parents. These families lived in a nearby area, Tımussom, with buildings of similar age and construction, but with appropriate upkeep.

Methodology
Airborne allergen levels in dust were measured in dust samples collected from the apartments at several locations. The consent was given by the occupants; the kitchen, the child’s bed and/or a parent’s bed and a carpet in the living room, if present. All samples were analyzed together, to reflect the nature of general exposure in the apartments. The health communicators visiting the home vacuumed the floor, mattress, carpet separately for 5 min each with a suitable vacuum cleaner (Vax, North America, Copenhgen, Denmark). The dust samples were stored at –18°C for at least 3 days to keep possible house dust biodes since sending them in batches to the laboratory at Occupational and Environmental Medicine, Skåne University Hospital, Sweden. House dust mite (D. pteronyssinus and D. farinae, Der p 1, Der f 1, and Der 1, lar 1, resp.), and cockroach allergen (Bla g) concentrations were measured using a Sandech ELISA methodology using reagents from Immuno-Biotechnologies (Charlestown, MA, USA) expressing the allergens as ng/g dust. The lowest level of detection was set at 50 ng/g. A level of >2000 ng/g (≥2 mg/g) dust was defined as high (corresponding to the level usually measured to be indicative of risk for sensitization and symptoms of allergic disease.

Family study visit
All children from the base-line study, together with parents and siblings regardless of age were invited to skin prick tests against a standard panel of allergens, including house dust mites plus cockroach at a local community center. Tests were carried out by qualified study nurses according to usual international guidelines.

RESULTS
1. There was an overall number of 650 participants from 130 families. The place of birth was known for all participants: 85% of all children between 0 and 13 years had been born in Sweden. All children that had been born outside of Sweden entered the country well before their second birthday. All parents had been born outside of Sweden.

2. Allergen content for dust samples from 130 apartments:

- Der p1
- Der f1
- Bla g

<table>
<thead>
<tr>
<th>Der p1</th>
<th>Der f1</th>
<th>Bla g</th>
</tr>
</thead>
<tbody>
<tr>
<td>High &lt;1 (above 2000 ng/g)</td>
<td>Low &lt;1 (200 to 2000 ng/g)</td>
<td>Present &gt;1</td>
</tr>
<tr>
<td>Under detection level 1:100</td>
<td>Under detection level 1:38</td>
<td>Under detection level 1:124</td>
</tr>
</tbody>
</table>

Subjective/defensive dampness and elevated house dust mite allergen concentrations in dust

- 12 households had measurable quantities of both Der p1 and Der f1 allergens in their dust samples.
- All households with detection of the pt allergen also had detectable Der f1 allergen, and in all of these cases Der f1 concentrations were high or very high.

- All those with detectable dust mite allergens could identify suspicious or subjective signs of moisture in the apartment, but were not in the worst category of damaged apartments. There was no statistically significant association between household status “crowded” and presence of both allergens in the dust.

- In general there was some overlap between apartment characteristics and the presence of HDM allergens in dust samples, but more on an observable trend rather than statistical association.

Cockroach infestation and cockroach allergen in house dust

- According to the questionnaires, 49 households had ever had a presence of cockroaches in the apartment at 20 which currently, only 6 households had any measurable corresponding allergen content in their dust samples. Only 2 in the 20 apartments with reported current presence of cockroaches was there any detectable antigen in the dust, and only in 4 of the 48 apartments with reported ever presence of cockroaches was there any detectable allergen in dust.

Allergen in dust samples and health data

- On a family level, presence of measurable allergen content of Der p1 in dust from the apartment was significantly associated with a higher risk of any family member being sensitised against Der pt (p=0.036). This also was seen for Der f1 allergen presence and sensitization of any family member (p=0.020).
- Presence of HDM allergen in dust samples was not associated with other health outcomes on a family or individual level.

DISCUSSION
Considering the high number of apartments with reported indoor moisture/dampness problems, it was somewhat surprising to find HDM-antigen below the level of detection in so many instances. When examining the connection between HDM-allergens in dust and health data, there was indeed a signal on the family level. Sensitive as determined defined on the background of AHR in atopic children, but rather in an IgE-mediated reactivity which could or could not put the individual at risk for symptoms of allergic disease.

The signal detected in this study was not of a strong and uniform nature. No significant correlation between allergen levels in dust samples and meaningful health outcomes could be detected on an individual level.

The striking lack of association between reports of cockroach infestation and detection of the corresponding allergens in house dust samples could be due to low reporting errors, or due to technical issues with the dust collection and test. The environmental and sociocultural conditions of our study may not be entirely unique. A certain degree of transferability of the results to similar climatic and societal conditions in high-income countries of the global North may be present.

CONCLUSIONS
Collection of dust samples and measurement of allergen concentrations for house dust mites and cockroach did not add discernible value in our investigation into the health in its social context in immigrant families in Malmö. Results in this context might be better spent in proper documentation of social and environmental factors influencing health during the home visits in which we have little doubt.

The addition of “objectively” measured variables into the evaluation of the social determinants of health could be challenging, as there is no clear-cut complex system of potentially harmful and protective factors – attempting to isolate simple components may be tempting, but may not lead to meaningful interventions.

Addressing housing related health variables will be of continued importance as housing in many parts of the world will have to be redefined in terms of its climate impact in the very near future.

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5. Overview of study area (Hæringen)