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Exploring the associations between parent-reported biological indoor environment and airway-related symptoms and allergic diseases in children

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ABSTRACT

Objectives: Asthma and allergic rhinitis are diseases which require special attention in childhood. Risk factors for these diseases are manifold and include environmental factors. Previous studies have shown associations between indoor mould and respiratory diseases in children. Besides indoor mould, organic waste storage, potted plants, pets and crowding could influence the microbial indoor environment at home and the respiratory health of children. Our aim was therefore to explore the associations of these factors with airway-related symptoms and respiratory diseases in preschoolers.

Methods: In this cross-sectional study we evaluated data based on parent-questionnaires regarding the health of their children from the 2014/2015 Health Monitoring Units (GME) in Bavaria. Bivariate and multivariate odds ratios (OR) with 95% confidence intervals (95%-CI) were calculated with logistic regression to explore associations between exposures (visible mould, organic waste storage, potted plants, pets and crowding) and outcome variables (doctor diagnosed allergic rhinitis with symptoms in the last 12 months, doctor diagnosed asthma with symptoms in the last 12 months, 12 month prevalence of symptoms such as dry cough at night without a cold, wheeze, wheeze attacks and allergic rhinitis symptoms).

Results: We analysed data from 4732 children (response rate 56.7%) with a mean age of 5.3 years. Visible mould was present in 4.7% of all households and associated with doctor diagnosed asthma with symptoms in the last 12 months [aOR 2.16 (95%-CI 1.01–4.63)], wheeze in the last 12 months [aOR 1.60 (95%-CI 1.0–2.50)] and allergic rhinitis symptoms in the last 12 months [aOR 1.75 (95%-CI 1.07–2.87)]. Crowding was associated with dry cough at night without a cold in the last 12 months [aOR 1.71 (95%-CI 1.42–2.05). The other indoor factors showed no association with respiratory health of the children.

Conclusion: Our results, in line with previous studies, showed positive associations between visible mould at home and airway-related symptoms and allergic diseases in children irrespective of the effect of the other considered indoor exposures. Despite the low prevalence of mould exposure in our study population, our results suggest intervention should be taken for those who do have visible mould exposure at home.

1. Introduction

Asthma and allergic rhinitis are common chronic diseases in childhood with a great impact on the patients' quality of life (Böcking et al., 2012; Cibella et al., 2015; von Mutius, 2000). Risk factors for these diseases are manifold and include genetic and environmental factors (Asher et al., 2010; Kazani and Israel, 2011). Among the latter are microorganisms such as fungi or bacteria and their components or products which can be found ubiquitously. It is supposed that microbial exposure in infancy can be protective for developing asthma and allergies, which is known as the hygiene hypothesis. This preventive effect seems to depend not exclusively, but also on the kind of microbial

Abbreviations: CI, confidence interval; GME, Gesundheits-Monitoring-Einheiten (Health Monitoring Units); ISAAC, International Study of Asthma and Allergies in Children; KiGGS, Studie zur Gesundheit von Kindern und Jugendlichen in Deutschland (German Health Interview and Examination Survey for Children and Adolescents); OR, odds ratio; aOR, adjusted odds ratio; aOR1, adjusted odds ratio (model 1); aOR2, adjusted odds ratio (model 2); SD, standard deviation

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[1] Complete details for GME Study Group can be found in Appendix A.

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factors, their mixture and diversity (Ege et al., 2011; Smits et al., 2016; Strachan, 1989; von Mutius, 2016).

However, indoor mould has shown to be a microbial mixture which has almost consistently been associated with adverse respiratory health effects, especially allergic rhinitis, cough, wheeze and asthma (Jaakkola et al., 2013; WHO, 2009). Mould in this context is a mixture of different dampness-related agents including fungi and bacteria (Breuer et al., 2016).

Apart from visible mould, further indoor factors may have an influence on indoor microbial exposure. Organic waste storage at home was found to increase indoor microbial contamination (Wouters et al., 2000). Potted plants could possibly influence the indoor environment by releasing humidity and fungal allergens (Breuer et al., 2016; IOM, 2000). Studies about respiratory health effects of indoor plants have shown inconsistent results so far (Fagbule and Ekanem, 1994; Mo et al., 2003). Studies about pet ownership at home and effects on asthma or allergic rhinitis in children showed results ranging from adverse health effects to no association or even suggesting a protective effect (Chen et al., 2010). On the one hand, pets are sources of animal allergens that can lead to sensitization (Chen et al., 2010). On the other hand, pets at home can lead to an increased exposure with microbial factors that might explain a protective effect (Dunn et al., 2013; Fujimura et al., 2010). Moreover, residents at home could have an impact on indoor microbial factors (Hospodsky et al., 2012). Crowding may lead to increased humidity and microbial exposure (Antova et al., 2008; von Mutius, 2016). Studies about the effect of crowding on asthma and allergies are inconclusive and need further research (Cardoso et al., 2004; Gray, 2001).

As people spend much time indoors, assessment of indoor environmental risk factors for respiratory diseases is an important public health issue (WHO, 2009). Children are an important target group as they are more susceptible to effects of environmental factors on respiratory health (Hutter et al., 2009).

The current relevance of visible mould, organic waste storage, potted plants, pets and crowding for respiratory diseases in preschoolers in Bavaria is not known. Our aim therefore was to assess how often this population is exposed to these factors at home and analyse their associations to airway-related symptoms and allergic diseases.

2. Material and methods

2.1. Data collection

This cross-sectional study is part of the Health Monitoring Units (GME) which take place in six different regions in Bavaria, three rural and three urban regions (for more details see Bolte et al., 2007). All parents of children invited for the obligatory school entrance examinations were asked to fill out a questionnaire. The 2014/2015 survey contained questions already used in other studies (ISAAC, KiGGS) about home environment and children's health (Kurth et al., 2002; Weiland et al., 1999). Approval from the local ethics committee was obtained (Bolte et al., 2007).

2.2. Exposure to indoor environmental factors

The variable visible mould at home (no/yes) was created to encompass the following areas: child's room, living room, parents' bedroom, kitchen, bath and hallway. The variable organic waste storage for more than two days (no/yes) included organic waste storage in the kitchen, the storeroom or the hallway. Potted plants at home were categorized in no plants, 10 or less plants or more than 10 plants. Pets at home (no/yes) included any kind of pet at home. Crowding was defined as more than 1 person per room (including kitchen but not counting bathroom) or less than 20 sqm living space per person (including kitchen and bathroom) as described in previous GME-surveys (Weber et al., 2016).

2.3. Airway-related symptoms and allergic diseases

Parents were asked if a doctor had ever diagnosed asthma (no/once/several times) in their child. This variable was dichotomized into no versus yes. Related symptoms for asthma were assessed asking for a 12 month prevalence of: dry cough at night without a cold (no/yes), wheezing in the chest (no/yes) and frequency of wheeze attacks (none/1 to 3/4 to 12/ > 12). Wheeze variable for number of attacks was dichotomized in less than four attacks versus four or more attacks as done in previous GME-studies (Weber et al., 2016). The variable "doctor's diagnosed asthma with symptoms in the last 12 months" was a combination of doctor's diagnosis of asthma ever and dry cough at night in the last 12 months and/or wheeze in the last 12 months.

Additionally, parents were asked if a doctor had ever diagnosed allergic rhinitis (no/yes) in their child. For allergic rhinitis related symptoms in the last 12 months, parents were asked if their child had a problem with sneezing or a runny or blocked nose when he/she did not have a cold or the flu (no/yes) and if these symptoms were accompanied by itchy-watery eyes (no/yes). Allergic rhinitis symptoms were defined as a positive answer to both questions. The variable "doctor's diagnosed allergic rhinitis with symptoms in the last 12 months" was a combination of doctor's diagnosis of allergic rhinitis with the above mentioned nasal and eyes-symptoms in the last 12 months.

2.4. Confounders

As confounders, the following parameters were taken into account: children's age, sex, older siblings, country of birth, rural/urban residency, parents' education and current second hand smoking as reported in earlier GME publications (Weber et al., 2016).

The country of birth of the child was dichotomized into "Germany" versus "other country". Rural or urban residency region was grouped as described in previous GME-surveys (Bolte et al., 2007). Parent education was defined as the highest graduation of mother or father and was divided into 3 categories: high defined as "Abitur" (A-level), middle as "Realschulabschluss" (middle school) and low as "Hauptschulabschluss" (secondary school) or none. Current second hand smoking was defined as smoking of third persons at home in the presence of the child (no/yes).

2.5. Statistical analysis

Reported indoor factors and airway-related symptoms or allergic diseases were described using absolute and relative frequencies.

Correlations among exposure variables and possible confounders were tested to avoid multicollinearity (Spearman for ordinal variables, Cramers V for nominal variables, threshold for both > 0.3).

ORs and 95%-CI were calculated with logistic regression to estimate associations between these parameters. Multiple logistic regression was used to control for possible confounders. Outcomes of the models were the aforementioned airway-related symptoms and allergic diseases. In a first model (model 1) we adjusted for age, sex, older siblings, country of birth, rural/urban residency, parents' education and second hand smoking. A second model (model 2) was calculated including all exposures (visible mould, organic waste storage, potted plants, pets and crowding) and the aforementioned confounders. Therefore with model 2 the independent association of the respective indoor exposures could be observed also in contrast to model 1 which includes just socioeconimoc parameters.

Statistical analysis was performed with SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA).